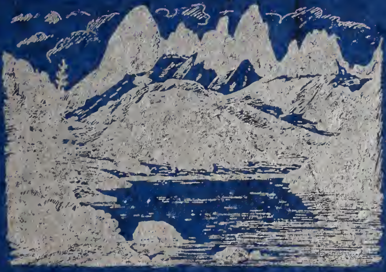

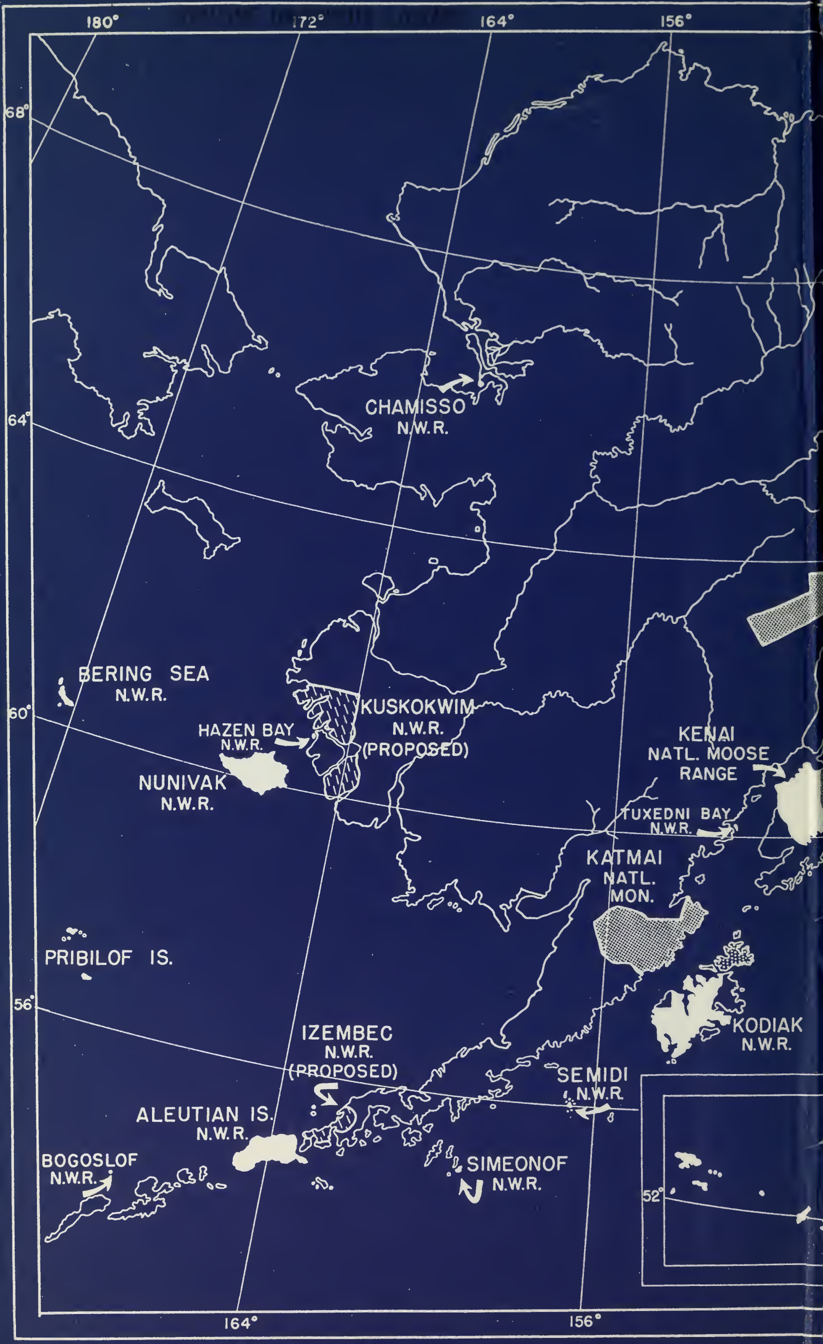
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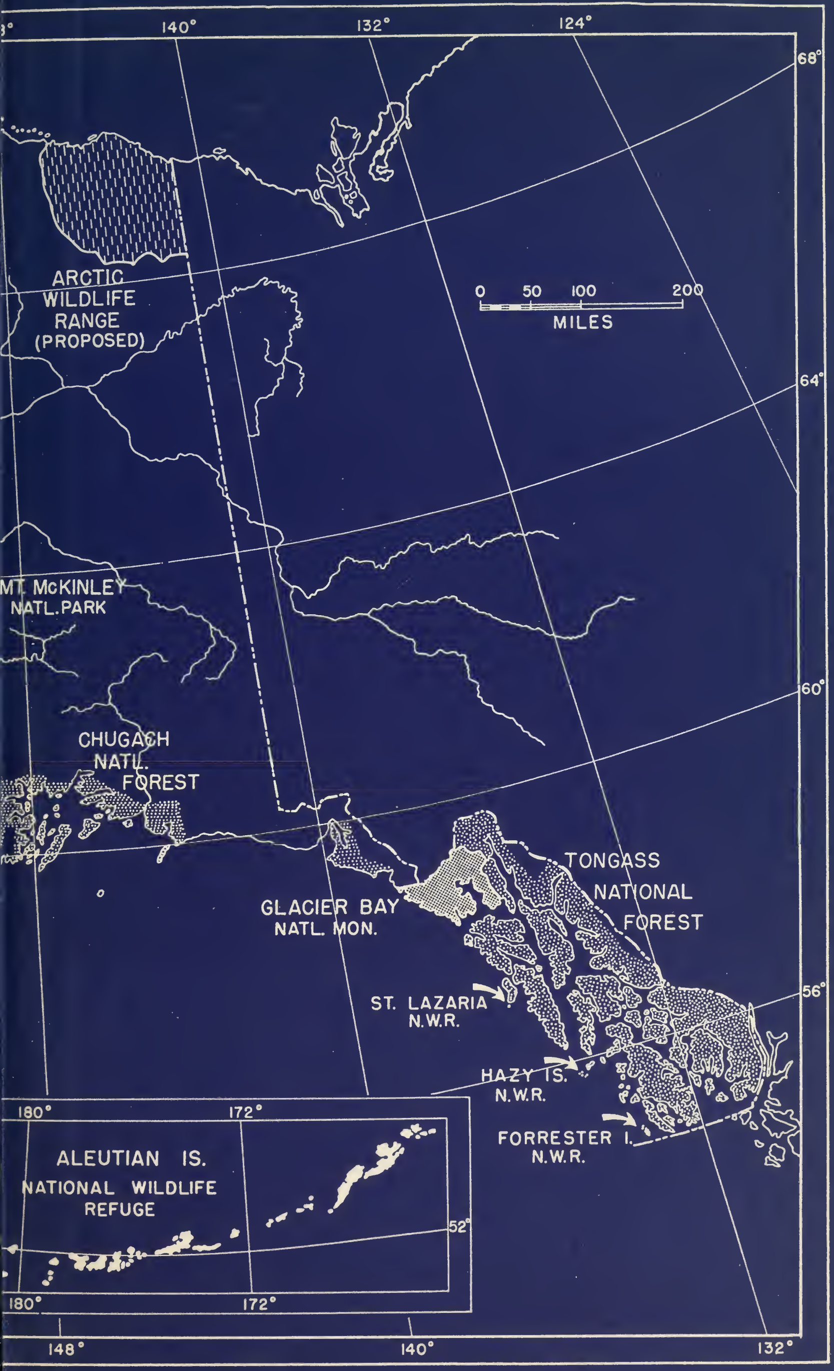

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TONGASS NATIONAL FOREST
GLACIER BAY NATL. MON.
ST. LAZARIA N.W.R.
HAZY IS. N.W.R.
FORRESTER I. N.W.R.
ALEUTIAN IS. NATIONAL WILDLIFE REFUGE

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of the Biennial Wilderness Conferences

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THE MEANING OF WILDERNESS TO SCIENCE

PROCEEDINGS, SIXTH BIENNIAL WILDERNESS CONFERENCE

principal contributors

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Stanley A. Cain
Ian McTaggert Cowan
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Robert Rausch
G. M. Trevelyan

edited by David Brower

The Meaning of Wilderness to Science

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Geological Survey
National Park Service
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THE SIERRA CLUB, founded in 1892, has devoted itself to the study and protection of national scenic resources, particularly those of mountain regions. Participation is invited in the program to enjoy and preserve wilderness, wildlife, forests, and streams.

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FOREWORD

Six Biennial Wilderness Conferences have been held in the San Francisco Bay region since 1949 under the sponsorship of the Sierra Club. They began with the idea of hearing out the views of various users and administrators of wilderness in the Sierra Nevada on the question of how to enjoy wilderness without wearing it out, or, stated another way, how not to love it to death. It all could be summarized as the threat from the *inside*, a threat not to be minimized.

But the first conference had hardly got under way before people realized that the inside threat, important though it was, paled before the *outside* threat, the threat to exploit wilderness to extinction. The vanguard of wilderness preservers saw that it would do little good to argue about whether to bury litter in wilderness or to carry it out if, meanwhile, mop-up crews of exploiters were busy rolling up the boundaries of wilderness and getting rid of it.

It was noted that each exploitative group was fond of wilderness, and wanted only its own special kind of concession in it—just roads to take out the bug trees and improve the forest so that it would not be a biological desert, or to enable sportsmen to harvest the surplus game because it was a biological Eden, or to make it accessible to the lame and the halt, or to harvest the tree crop to avoid waste; just water development to maintain streamflow or improve forage for deer or to render it more accessible for outboard motors or to enhance the scenery; just a chance to try out man's new experiment, wildlands management. Each concession was admirable in itself. Each necessary in its place. But was wilderness the place? Or was wilderness something that needed guarding more than managing, careful respect for the forces that had built it and kept it, that were still building it and could still keep it, without benefit of man's technology? Was it possible that the chief managerial task in wilderness was to manage management lest wilderness, by definition, be managed to death?

There was growing conviction that wilderness could enhance the American standard of living—if the American standard of *having* did not extinguish wilderness first. It was postulated that if America were to ignore, for utilitarian purposes, that small part of its land area which is still wilderness, if America were to consider it there just to be enjoyed for what it is and not for what it could be remodeled into, then the nation would still survive handsomely—perhaps even more so. Just pretend it isn't there, the theory runs, and carry on business as usual *around* it; you won't regret it. There isn't too much heresy in the concept. Successful corporations call it a reserve. A successfully civilized nation ought to be able to set aside a reserve, not of money for a rainy day, but of wilderness for a rainy century—and enjoy it *as wilderness* until the rains come or even beyond that.

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Early conferences cast about for some way to achieve this. Surely there must be a role for at least two branches of the government of a nation if something as irreplaceable as wilderness was at stake on the nation's land. The Executive Branch could designate and guard it, but the Legislative Branch should at least recognize it and grant wilderness an automatic stay of execution, whoever might wish to cancel it out. Out of all this the Wilderness Bill emerged. And out of the extended consideration the various versions of the bill received, the meaning of wilderness in the whole context of national resources became clearer. Perhaps what follows is a fair sketch of the relationship that has been seen to exist.

IT HAS BEEN THE CUSTOM to look at natural resources as of two kinds—renewable, such as foods and fibers; and nonrenewable, such as metals, minerals, and fossil fuels. It is now of major importance to look anew, to consider not how renewable a resource is, but whether we have prospects of finding a substitute for it.

This is so for two reasons:

1. Our rate of depletion of the "nonrenewables" is accelerating in spite of our knowledge of the following fact, succinctly put by Sir Charles Darwin: "During the whole of man's history there has been a great deal of mineral extracted from the earth, gold, copper, iron, coal, and so on. *More than half the grand total* of these metals and minerals has been taken out of the ground since 1920" (from the Rede Lecture, 1958, Cambridge).

2. Our renewables depend entirely upon the earth's thin skin of soil, and we are wasting these, at a rapidly increasing rate, through erosion by water and bulldozer; through burial, inundation and poisoning; and through eradication of species of unknown value to man's own future.

We know from the U.S. Geological Survey that the prospects are good of finding substitutes for the nonrenewables—through vastly improved technology in the processing of sea water and common rocks, aided by the almost unlimited store of energy from the atom and the sun that we are learning to control.

We have no assurance that we can find substitutes for the myriad, and for all we know, indispensable forms of life—in the soil, on the land, and in the air—upon which the entire chain of life depends.

Wilderness. The most important source of the vital organic forms constituting the chain of life is the gene bank that exists in wilderness, where the life force has gone on since the beginning uninterrupted by man and his technology. For this reason alone, it is important that the remnants of wilderness which we still have on our public lands be preserved by the best methods our form of government can find. The proposed National Wilderness Preservation System (now before the Congress) provides an excellent route to that goal, and especially dynamic leadership in the Congress and the Administration will be required during the next decade to really achieve the goal of wilderness preservation which the System would make possible. There will be important subsidiary benefits to recreation, to watershed protection, and to a continuation of the beauty of the native American scene.

A growing economy will have availed us nothing if it extinguishes our all-important wilderness. A gross misunderstanding of wilderness, in which it is evaluated according to the number of hikers who get into it, has been fostered for the past several years, to the great detriment of all the future. There must be no more needless, careless losses. There is no substitute for wilderness. What we now have is all that we shall ever have.

Other resource problems are of secondary importance, but still far more important than one would assume from a regular perusal of the nation's financial pages, or from most public speeches.

Forestry. The government badly needs a program that will bring to forestry a full realization that forests mean far more than timber and pulp. On many forests other uses should be given precedence, but rarely are. The overwhelming emphasis in the training of forest-land managers, and in the decisions they make, is on timber production. Reforestation, watershed protection, recreation, wildlife restoration, and wilderness preservation are suffering severely as a result.

Water. Reliance upon the reimbursable dollar as the primary criterion for water development can bring about bad projects and prevent good ones as long as there is no satisfactory means of assessing the perpetual dollar value of natural land and streams. The nation needs to proceed without delay to a classification of streams that will present to future generations a countryside with optimum water development and wild-stream preservation. Some of the streams should be primitive, some semi-primitive, some partly developed, and some fully developed. We have waited too long already to develop a national water plan based upon this simple and clearly necessary foundation. The interim delay in the effort to clean up open sewers cannot be continued.

Parks. Little time remains in which to rough out the undedicated areas having high scenic, wilderness, and wildlife values which should be added to the National Park System. The only error we can make now is to preserve too little. It has been much too long since a major scenic reservation was made in the United States proper, either by creation of new national parks by Congress or national monuments by proclamation. There has been too much "Let Roosevelt do it"—Teddy or Franklin. There is far too much parochialism evident now that the effort to round out the parks is getting belatedly into motion. Some 180 million acres were set aside as national forests in a bold, sweeping motion more than half a century ago. Within these areas are some of the finest potential parks, and a transfer of a small fraction of the national-forest total could greatly enrich the National Park System without appreciable impoverishment of our national forests—especially when the nation has some fifty million acres of forest land that was allowed to become impoverished and is critically in need of reforestation.

Wildlife. We need an expanded program of habitat improvement on developed lands and a fuller understanding of the importance, to many species, of preserving a natural regimen, in wildlife refuges and game ranges as well as in wilderness. Of primary importance is a still more intensive program of research in methods of control of herbicides and pesticides so as to reduce peril to wildlife and to man.

Roads and highways. Construction of roads has proceeded so rapidly that there has not been time to evaluate properly their cost to the nation in terms of impairment of the economic feasibility of efficient mass transportation, or in terms of the cholesterol laid down in the cities' arteries, or in terms of soil, beauty, and wilderness lost. It is now time to reappraise the high priority given to roads in the expenditure of public funds in view of the lagging programs in many critical fields, such as education, world health, redevelopment, and preservation.

* * * * *

We have lately been playing a game of strip poker with the American earth. A relatively few people have been winning the early hands—people interested in quick profits from the sale of conveniences—and all but guaranteeing that our children will lose as the game goes on, not just conveniences, but necessities as well.

We need wider realization that milk does not come from a bottle, nor water from a tap, nor gasoline from a throttle. These are all part of our natural resources, wealth put by nature on the only world we are ever likely to live on comfortably. The nation needs men who can match its mountain depleters, who will realize that man must never again deplete, at the rate he has been depleting since World War I, resources of the earth for which there are no known substitutes, including the tiny vestige which constitutes all the remaining wilderness on the earth.

Perhaps this would have been thought an extreme appraisal and not a fair one, a few years ago. But not any longer. For there is a rapidly growing readiness to scrutinize these issues, and not to dismiss them merely because they may not accord with the Conventional Wisdom. These are issues to be faced honestly in man's own interest, if survival interests him. Other species—and wilderness too—will then also survive as a happy coincidence.

David Brower
Executive Director, Sierra Club

Berkeley, California
April 28, 1960

ACKNOWLEDGMENTS

IN THE NOVEL *The Roots of Heaven* one of Romain Gary's characters says, "What this world needs is an Einstein of biology." Perhaps one exists now. Conceivably, one of the biologists represented in this book *is* that person, and only needs to be given public recognition as such. The reader is free to select his own candidate or nominate someone from the outside, free also to think hard about what such an Einstein should accomplish—if it is to be accomplished in time—and what help he will need.

The reader who does think hard will realize soon that this volume only begins to tell what its title encompasses. The title should at the very least have a "Volume I" added to it, but this would depart from the title of the Wilderness Conference which this book reports and might tend to make static the titles of succeeding conferences. A great many sciences are not represented, not the least of these the Social Sciences and Political Science. We hope that wilderness will engage the attention of these sciences more fully than it has—and soon enough. Meanwhile we can only suggest, in an Appendix, some of the subjects that they might be pondering. The Appendix is an extraordinary paper that was brought to our attention by the late Judge Robert W. Sawyer. To us, it puts this whole volume in the round—or at least gives it another side.

The principal papers evolved a little differently from those of the usual conference. The speakers prepared drafts, but none followed this draft to the letter, and some used the draft chiefly as a point of departure. The conference was put on tape, the tape transcribed, the transcription edited by Warren Olney IV to add a few of the written amenities not always present in the spoken word, and the final version submitted to the speaker and corrected again by the speaker in galley—with the inhibitive request that everything be left just as much as possible as is to avoid further delays in publication. Thus the papers may or may not be the literary product the authors would otherwise have liked. They are, however and at last, published.

* * * * *

We think the Biennial Wilderness Conferences are unique in the array of talent and devotion they bring forth from volunteers. The Sierra Club is grateful to its members and its friends who made the Sixth Conference possible, and in particular to the sister organizations who lent both financial and moral support—Resources for the Future and the Conservation Foundation. We are grateful, for illustrations, to contributors to the *Sierra Club Bulletin* annual magazine numbers for 1950, 1952, 1953, and 1956, as well as to Vivian and John Schagen, who, in giving this book their extra, expert scrutiny, suggested that there was a unity in these photographs of Alaska which deserved wider audience here.—DB

THE SIXTH BIENNIAL WILDERNESS CONFERENCE

SAN FRANCISCO, MARCH 20, 21, 1959

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WELCOME

On behalf of The Wilderness Society, the California Academy of Sciences, Resources for the Future, the Conservation Foundation, and the other cooperating organizations, I welcome you all to this conference. It is the sixth of a series which began in the spring of 1949 and which is devoted to the values and the problems of wilderness.

Previous conferences have been motivated by our love for our wild lands and the values they represent to us in terms of inspiration and recreation: intangible values which are intensely individual and intensely personal, produced by a type of environment which can evoke a mood. Because we love and need to experience this mood, the environment which can produce it is to all of us very precious. It grows more precious as it grows more scarce and more difficult to find. Because we love it, we instinctively seek to understand and to preserve it.

Problems of the use and preservation of wilderness have been our major concern in the conferences which have preceded this one. Today, we turn more specifically to explore the values of wilderness—not in terms of the human spirit so much—but in terms of their value to the fields of science. We have here assembled a galaxy of experts in the broad field of ecology. They are from all over the world and represent many specialties. It is a rare privilege indeed to have this opportunity to share some of the fruits of their work and the wisdom which it has brought to them. I would welcome them and thank them for what they contribute.

Since this is a conference devoted to the value of wilderness to science, it is fitting indeed that we should have as chairman, now and in the long planning stages that have preceded, Dr. Robert C. Miller, himself a distinguished scientist, the Director of the California Academy of Sciences.

Harold C. Bradley
President of the Sierra Club

DANIEL B. BEARD

Plants and Animals in Natural Communities

Daniel B. Beard brings to his subject a considerable background of experience. His work has taken him to New York, Florida, the Midwest, Utah, and most recently to the State of Washington. He became Superintendent of Olympic National Park in June, 1958. Mainly, his affiliations have been with the National Park Service and the Fish and Wildlife Service, but he has worked with other Government offices as well. On January 1, 1960, a promotion took him to Washington, D.C. to take office as Chief, Division of Interpretation for the National Park Service.

Mr. Beard argues that scientists and conservationists have a mutual interest in wild lands preservation. Wilderness is necessary to science, and science is necessary to preserve the wilderness. But this common interest lies in wilderness as a self-sustaining whole, composed of dynamically interrelated parts: as such it is important to science, and only if it is approached as such can it be preserved by science: by awareness of wilderness as a whole, we mature as conservationists, and we are better able to make a case for conservation in terms of its positive scientific value.

A Mission 66 objective of the National Park Service, ". . . proposes a much strengthened program of research and observation. . . . The normal pace of nature is slow, and the influence of man upon his environment is often indirect, obscure, and delayed, and often not recognized in time to take preventative action. . . . Guesswork, rule-of-thumb, and intuition are not good enough. . . . The preservation of this irreplaceable (wilderness) resource requires precise knowledge and scientific procedure. . . ."

When we think of research or investigation in wild land areas, we naturally picture the zoologist, botanist, forester, ichthyologist, geologist, or geographer as the scientists most interested. I think it is most encouraging that you have brought into this conference the discussions of other branches of knowledge—philosophy, sociology, economics, and psychology—and by so doing urged their practitioners to become more actively interested in wilderness as it relates to our civilization. We need them.

Someone has made the provocative suggestion that we need a distinctive wild land or wilderness literature. One might say that this is already in existence although admittedly scattered. I doubt it. The real student of wilderness—and there are very few—will find it rather difficult to find data that can be used as a springboard for his inquiry.

Perhaps I am not making myself altogether clear on this point. Much has been written on various phases of wild lands. Studies exist, and even our friend Walt Disney has used his persuasive medium on this subject. But, except for the philosopher who has been inspired by wilderness, how much has been explained about this very fragile, almost nebulous phenomenon when compared to the total output of science?

So, perhaps we are trying to sort this out a little here, to get the measure of the need, to attempt some overdue self-appraisal if we are to substantiate or even develop to acceptable maturity our ideas on wilderness.

Except in well protected public areas, there is the abhorrent spectacle of something precious apparently melting away before our very eyes. And there is concern because we are challenged on every hand to prove that there is such a thing as a purely economic wilderness—and if not, why in the world should it be allowed to exist? It is hard to explain it to one who is insensate, yet we hope that the popular conception of a wilderness area as just a place that has not yet been found of economic value is receding. That idea, which developed during our long history of wilderness exploitation, is certainly an entirely understandable one, but it is now becoming slightly old-fashioned.

To repeat, it appears that a distinct wild land or wilderness literature is required to bring into positive focus the values of such areas and such conditions to modern society. It would seem that the appeal to date has emphasized the emotional value of wild lands mainly as historic relics interwoven with the inspirational.

It seems to me that the need for research in wild lands is especially important in the biological fields, even though the intriguing science of ecology is beginning to contribute a great deal to our knowledge. Up until this vigorous young science became important, the biologist was often busy with the ABC's of his profession: naming, cataloging, describing, and inventorying plants and animals. Aldo Leopold pushed the broader concepts of wildlife management onto the stage, where other hands had already been busy with such props as predator control, manipulation of the environment, and other techniques for rebuilding or even overbuilding wildlife populations in an environment changed by man. Those scientists whose business or interest carried them into the wilderness had to borrow their tools, techniques, and knowledge from those whose interests were to increase game or timber yields. I hope that I am not doing them a disservice when I suggest that these wild land scientists have been all too few and that not many were permitted the luxury of being true investigators of the wilderness itself, as were and are John Muir, John C. Merriam, F. Fraser Darling, Starker Leopold, the Muries, and a few others.

The ecologist uses the idea of natural communities as one of the foundation stones of his craft. It is a term that has opened many new doors, but most of us find that the doors open into technical mazes wherein we can easily get lost. However, it is not too difficult to grasp what natural communities mean: that plants and animals have a relationship one to another even to an interdependence for their very existence.

The authors of the book *Basic Ecology* wrote: "Though the communities themselves, because they overlap and because they change, have not yet been completely pinned down, the community concept is clear enough. And it is perhaps the most significant of all ecological concepts—it brings together into meaningful story the myriad details about plant and animal structure, distribution, and habits that have accumulated through the centuries. The wholeness of the community, the interdependence of its members is a simple enough idea once it is pointed out. Yet it was not clearly apparent even to the most careful scholars before the necessary facts became known." To use the old saying: ecology explains something everybody can understand in terms nobody can understand.

Paul Shepard, Jr. said in part: "The discovery of this interdependent, self-adjusting community, dynamically in balance with the total environment, is a landmark of human thinking . . . The influence of this ecological information may lessen the gap between man and nature which has been developing since the industrial revolution." Along the same line, Aldo Leopold was quoted in the *Sierra Club Bulletin* as saying: "The outstanding scientific discovery of the twentieth century is not television, or radio, but rather the complexities of the land organism. Only those who know the most about it can appreciate how little we know about it." [From *Round River* (Oxford, 1953).]

Well, I am not so sure that I bristle with such enthusiasm for the discovery as do Shepard and Leopold, but I *do* get their point. And I thank them for saying it so that my authority can underscore theirs. Certainly, the artist who understands composition, juxtaposition of light and shade, repetition of shapes and figures, texture, and color is better able to appreciate a picture than the person who does not know these things. In the same way, appreciation of wild places, aesthetic enjoyment, and regard for nature are related directly to the degree in which we are aware of the existence of these natural communities of plants and animals. A wild landscape thus becomes meaningful and so intensely interesting that the avid bird watcher becomes so absorbed that he forgets to note every species for his life list, and the sturdy rock climber neglects to climb the topmost crest.

And, as we mature as conservationists and human beings we develop a sensitivity to natural surroundings that we did not know existed before. But above all, we become less preoccupied with just one ingredient of the natural community—birds, lichens, trees, mammals, butterflies, or whatever the hobby or interest. Paul Sears summed this up in this way: "The whole history of the conservation movement has been an evolution from concern with single resources to realization of their interdependence and of the need for viewing the problem in its entirety."

If my audience of Californians will permit, I would like to illustrate this point by reference to a Florida area, the Everglades. At the time the new National Park was being created, many objected to its size saying that since the great bird rookeries and roosts were the central attraction, then why not include them alone. These people failed to realize that preservation of the whole living community was the purpose of the Park. They did not know, until told, that a hundred thousand or so ibises, egrets, and herons had to find tons and tons of food—crayfishes, fillifishes, snails, and so on. Water levels had to be such that these food organisms would be concentrated. Alligators needed to be present so that the 'gator holes would form reservoirs for the food organisms in the dry seasons and so on and on and on.

In the past however, the preservation of natural communities such as are found in our National Parks has sometimes occurred more because of luck than anything else. If you should read about the early campaigns to create Yellowstone National Park, it will surprise you to find little reference to plant and animal conservation. Stress was placed upon the thermal activity, the canyon, and the lake. The reason is simple enough: the wildlife, forests and grasslands were not yet in short supply.

But they are now, and I wish we could say that we have now seen the light regarding the need to give adequate preservation to the best of them. But it is not that simple. Anyone who has ever faced the task of determining or changing the boundaries of a National Park, Refuge, or National Forest knows that a hundred ecologists armed with all the knowledge we have gained in the last hundred years might not be able to prevail! But there are certain indications of progress.

The much disputed boundaries of Olympic National Park's west side were established to protect the range of the spectacular Roosevelt or Olympic Elk and the remnant of the great rain forest that identifies one of the most magnificent natural communities in this country. Biologist Coleman Newman found many reasons why the rain forest and the elk were, as the Spanish say, "muy simpaticos."

Scarcely noticed here on the West Coast, the boundaries of Everglades National Park in Florida were recently completed after one of the longest and most hotly contested controversies in conservation history. The decisions were made and the final boundaries drawn, after competent scientists in and out of the Federal Government had identified natural plant and animal communities. These scientists included among many others ornithologists, botanists, geologists, and marine biologists, not to mention philosophers, economists, industrialists, and practical politicians who also were indispensable in this community of effort and achievement. It was a good job, and we are proud of it.

The National Park Service has made some pioneering attempts to show the value of establishing certain areas through investigations and studies of their most important resources, and the meanings and uses of such resources to science. One of the outstanding achievements which comes to mind is the Katmai Project. That project was occasioned by our realization that we knew very little about the scientific significance of Katmai National Monument, in Alaska—the largest in the National Park System. The Service went to work with various other agencies, including the Office of Naval Research, the Office of the Quartermaster General, the U. S. Coast Guard, the Air Force, the University of Alaska, and many others, undertaking a pretty complete field investigation of the geology, mineralogy, biology, entomology, geography, archeology, terrain appreciation, visitor use potentials and administration, transportation and communications, and a number of other factors and phases. The results of that project, which extended through two or three years of field work, are encompassed in a series of about 12 articles and reports (including one definitive report on biology by Victor Cahalane), all of which the Service is using penetratingly and diligently in developing Service awareness of the area's needs in utilization and protection now and in the future.

Those who have knowledge of the history of Big Bend National Park will remember that much the same thing happened there. These are but a few examples. So it appears that there are instances where reasonably well defined plant and animal communities are being preserved in approximately their natural condition.

You will recognize that my remarks apply mainly to National Parks, because that is my field. What I have said might be applicable to other wilderness or wild land areas. You may have noticed also that I have made several qualifications such as "*reasonably* well defined" and "*approximately* natural condition." We might say that Mount McKinley National Park is an excellent place for the Dall sheep, and that that species fits nicely and neatly into its so-called ecological niche as a part of the whole community. You could not very well say that about the caribou, except at the particular time when it happens to be migrating through the Park. This is oversimplification, I admit, but you know as well as I do that it is probably impossible to find anywhere—in the 50 states at least, with the possible exception of Alaska—any large natural plant and animal communities left that can be called complete down to the last detail.

The wilderness wherever it can be found today is certainly the place where the scientist and the wild land manager can work in full accord with benefit to both. It is a place where the emphasis on research is badly needed, because the measure of our success is in how closely we can approach the goal of approximating natural conditions. It is not enough to be satisfied with the conditions as they are, because the status quo may itself deceive us.

The concept of the balance of nature in the older sense has already fallen before the ecologist. He ventures the term "steady state" but qualifies it by speaking of a changing, shifting, moving equilibrium that tends to move in a determinable direction but never settles into a static, comfortable climax as we used to suppose. As John C. Merriam often told his students: "Creation is a continuous process." The ecologist tells us that nature attempts to determine what species and associations are best suited to the maximum efficient use of a site or environmental resource—but nature never stays quite still enough. In point of fact, there are indications that the North American continent was in a pretty unstable situation when the white man first arrived.

As a result, we have somewhat tardily become aware that we are in danger of trying to freeze the status quo of our wilderness or wild lands at a certain point, or a certain stage—an idea that never occurred to most of us twenty years ago. Not only that, but by overprotection of our wild lands and wild land communities, we are beginning to suspect that our efforts might be pushing nature into directions she might not want to go. We know only too well that this might eventually lead to some entirely unexpected and tragic results.

For instance, fire can be very destructive as everyone knows. F. Fraser Darling and Starker Leopold showed that in the study of fires that destroyed the lichen food of the Alaskan caribou. But wildfire has been a factor in the natural landscape. It has favorable effects on certain species of plants and animals. It causes some seeds to germinate. It reduces grass litter and allows tree seedlings to come up. Research recently completed on one forest type shows that fire protection has endangered the existence of the dominant trees along with many endemic plants that grow only where wildfire has been. The distribution of brown spot disease on longleaf pine seedlings in the South is said to be naturally controlled by fires. In many areas, fire protection has allowed the build-up of fuels and set the stage for catastrophic fires.

Simply stated, we are beginning to recognize that the role of fire is really not as well understood as we thought. Starker Leopold has touched on this point in past wilderness conferences. The battle to prevent and control fires has so preoccupied some of us that we have, once more, carried the techniques and knowledge of economic landscape management into the wilderness and perhaps have unwittingly placed ourselves to some extent in the way of natural organic evolution which surely is nature's process of handling all life, including man.

Control of injurious species is another management technique that has sometimes spilled over from economic to wilderness practices. Although predator control has long been abandoned in National Parks, it used to be acceptable and has left its scars in extirpated or greatly reduced species which, in turn, have at times caused an eruption of prey. Obviously, control of wide-ranging predators beyond the wilderness boundaries has had the same effect. It is much the same with insect pests and disease or anything else we consider harmful or inimical to our concepts of wilderness preservation.

This all sounds extremely easy to solve: reintroduce extirpated species, let the wildfires burn, allow the insects to attack. And, while we are at it, let's get rid of all the things that were not a part of the natural scene, even including ourselves. It is not that easy. For one thing, the fire might not stay in the wild lands and the insect might find a way out too. And I would just like to see you get rid of people!

John Muir found the great forests of Washington in various growth stages. On closer examination, he discovered that this was because of fire, natural wildfire. Olympic National Park in Washington has the finest remaining stands of Northwest forests in their natural condition, in that they have not been severely molested by man. But the forests in the Park are less than one per cent of the Northwest's forest area. Fire, severe insect infestation which would devastate large areas, disease, or other things, no matter how natural, have the capacity to destroy this remnant or reduce it to a one-stage condition. To quote from the *National Park Wilderness* publication: "This requires that natural forces be regulated to the degree necessary to keep them in scale with the reduced size of the wilderness that remains today." And that is not so easy either.

Those of us who have anything to do with wild lands and natural plant and animal communities are warned, threatened, admonished, scolded, and bludgeoned with the logic of critics if the term "managed wilderness" escapes our lips. Yet we have been fumbling along these very lines for years and years. I think the boogieman conjured up is that of an Old World forest with trees neatly pruned, the litter cleared, and that intangible quality of mystery that is the hallmark of wilderness gone forever in a man-made landscape. Quite so. But if we are aware of the danger, why walk into it? I think we are sometimes so afraid of what we might do that we make the mistake of doing nothing or waiting until a real crisis has developed that intelligent, well-controlled interference would have prevented. But we had better know what we are doing and the only possible way is through continuing scientific research.

In this connection, I was amused by a barbed statement in the *Yale Conservation Studies* a year or so ago which went as follows: "Although the most important single element in the Parks is the visitor, one looks in vain for sociologists, anthropologists, or psychologists on Park staffs. Apparently the assumption is that the Park Service is still an agency which deals with land, enduring the public in summer."

In the so-called practical field, which we administrators and planners think of as our special province, there is always at hand overshadowing our immediate day-to-day material needs the larger concept of area meaning and usefulness in the philosophical and spiritual sense, which is what we are talking about here today. In other words, we are constantly conscience-struck at the enormity of disaster that might befall an area if we should as parkmen unwittingly admit something or other that would be too much for it in terms of overuse, or non-conforming use. Visitation itself in concentration zones becomes a nightmare which can only be met in the long run, I am convinced, through scientific determination of just how much and what type of visitor impact is possible commensurate with preservation. This should determine the facilities and services. By the same token, we can agree that nothing in park administration is static, any more than it is in the life history of an area. The change, for instance, of the traditional old lookout on the top of Clingman's Dome in Great Smoky to something modern and useful is a justifiable undertaking from various viewpoints, however unhappy it may leave some who feel that nothing at all should ever be done. They feel that the old log and rock architecture which we so frequently hear mentioned as ideal for the parks would be the best. Scientifically, the evolution of park architecture and public service generally, as illustrated by our modern techniques in construction and in facilities and services, is but a reflection of the progress made in understanding and utilizing intelligently basic park resources. It is far less expensive and decidedly more sensible today to use modern, less perishable materials from all the standpoints of design, construction cost, public use, and perhaps above all maintenance, than it ever was to use the materials which our forefathers, the pioneers, found locally and used only because they didn't have anything else. Except in some remote places as Katmai, the back country of Olympic, or some other where as a temporary stop-gap or frontier expedient, it is not necessary to resort to whatever is at hand. The Service is not justified today in the Administrator's translation of his area's meaning in using mud, rocks, logs, sod, or anything but the most modern materials except in highly specialized circumstances.

Last month, Massachusetts Institute of Technology reported that under controlled conditions in the laboratory scientists have learned that if they "bathe" tadpoles in an ultrasonic "bath" stirred at a rate of four million vibrations per second, the tadpoles will shake their tails and peel off an extremely thin layer of skin. This is of much interest to neurosurgeons of Massachusetts General Hospital as a surgical tool capable of aiming an ultrasonic beam to hit just fifty nerve cells without damaging anything else. The lowly tadpole that was needed for all this came from some wayside pool, and the controlled laboratory conditions sufficed for the studies. Some biological studies can be carried on without reference to habitats or other creatures and plants, others cannot be separated without reference to environment relationships. Great as our scientific advances may be, we are as yet unable to create wilderness indoors. Some say that we cannot restore wilderness either. Once it is gone it is gone, they say, and you might as well plow it up and plant corn.

The idea of wilderness restoration is not a popular subject in wilderness groups or, let us say, among livestock growers. The first group fears that it might lead to the entirely fallacious idea that existing wilderness need not be handled so carefully after all. The other group, livestock growers or farmers, or perhaps some chambers of commerce, or others would not like to see land now used for other purposes made into wilderness. Both groups are right and both groups are wrong, too. Wilderness restoration is now going on. For instance, Great

Smoky Mountains National Park in Tennessee and North Carolina is more of a wilderness today than it was before it became a Park, in spite of the fact that over 3 million people visit it every year. The forests are regrowing, the pristine areas are secure, and the animals once so scarce are coming back. In other words, communities of living things once depleted or changed are returning. It is a strange thing that man the destroyer is capable under many conditions of moving about in a wild land without adversely affecting it. The Great Smokies is a good example.

In the burned, beaten, and abused Everglades of Florida, the amazing fertility of the tropics is already re-establishing the mantle of wilderness throughout the 1,400,000 acres of interrelated natural communities, almost within sight of flamboyant Miami. The same recovery is noticeable at Big Bend National Park in Texas and at the desert National Monuments of California. Admittedly in each case, the ingredients were there; wilderness had not been completely eradicated. Numerous National Wildlife Refuges contain restored habitats, albeit artificial in places, where dust storms occurred twenty-five years ago.

Ecologists, agronomists, botanists, and many other scientists have spent years studying the grasslands which covered so much of the interior of this continent. They have had to work from traces only, because there was no other general vegetative type as completely destroyed as the prairie's. A few acres here, an old cemetery or railroad fill there, was all that could be found. Men like Weaver and Fitzpatrick could only reconstruct an idea of what it was like, because the prairie grasses grew on soil that was admirably suited for corn and wheat and could support grazing herds of cattle and sheep instead of bison and antelope.

Here was a case where the scientist was almost too late, where the biggest change had taken place before he came, but even at that the little pieces can be put together. In retrospect, we can wish that the dream of the unhappy painter, George Catlin, might have been realized—a great grasslands preserve with all its spectacular wildlife, including, according to Catlin, the wild Indians! But even as we say it, we know it would have been impossible on the scale Catlin visualized.

An attempt was once made to establish a grasslands preserve on a lesser scale, but it failed. Perhaps this is an example of a situation where a wilderness might still be restored, or recreated. What a fascinating opportunity for science to attempt!

These ideas sometime fall upon deaf ears out here in the West, because you have been more fortunate than those of us who came from the East, South, or Midwest. Our American culture had advanced far enough to spawn the conservation movement before the West was destroyed. The forests of the Olympics were not fated to be devastated like those in the northern lake states, Pennsylvania, and Ohio. You did not lose any heath hens, passenger pigeons, or great auks, although the golden bear of California now inhabits the football field only. But you are going to lose your seacoast if you do not watch out—a loss that will occur because so few conservationists or public officials have ever thought about the marine littoral as falling within their sphere of interest. I hope that the hike lead by Justice William O. Douglas along the Olympic Coastal Strip last summer and the recently completed—but not yet released—Pacific Coast Survey of the National Park Service will spark interest in and some realization of the very immediate problem of saving scarce seacoast areas. I mean of course the marine littorals, salt marshes, rocky shorelines, mud flats, sand dunes, and all that defines the seacoast.

About this time last year I was with an expedition to the Exuma Cays, a day's sail southeast of Nassau in the Bahamas. It was sponsored by the New York Zoological Society and the Bahamian Government. Our objective was to find and study an unspoiled coral reef, shoreline, and landscape. Shall we say we were looking for a seascape connected to a landscape. The only protected bit left (and it was not reef type) along the Atlantic seaboard in the United States was at Fort Jefferson National Monument at Dry Tortugas—a few acres only. Everywhere else in the States and around Nassau, Abaco, and other areas of the Bahamas, the living coral reefs with associated fishes, sponges, gorgonias, and so on had been destroyed or were in the process of being changed by commercial collectors, skin divers, pollution, sedimentation, or other causes. A reservation of Crown Lands and Waters at Exuma Cays was almost the last chance to save anything.

Along the eastern seaboard and gulf there are several National Park areas, Federal Refuges, State Parks and so on: Cape Breton Island in Nova Scotia, interesting little Fundy National Park in New Brunswick, Acadia National Park in Maine, Cape Hatteras National Seashore, Everglades National Park, and Fort Jefferson National Monument. But only at the latter two is there any jurisdiction which permits protection below high tide. Parks and reservations usually end right where the amazing biological phenomena of the marine littoral begins. In parks where you would be arrested for picking flowers you can step off into the intertidal zone and take all the sea urchins, starfish, and other things you want. The old adage that conservation ends at the water line still seems to apply.

The same thing seems to be happening on the Pacific Coast. Skin divers, scuba divers, spear fishermen, collectors both professional and amateur are taking to the biologically fascinating littorals. The coastal communities of plants and animals will unquestionably suffer and be depleted. Up along the Olympic National Park coast, where federal jurisdiction goes only to high tide, seals are shot from the beaches.

The maritime ecology is still relatively untouched at Channel Islands National Monument, located off the southern California coast, and the boundaries there do include the waters five miles offshore from Santa Barbara and

Anacapa Islands. However, under the Submerged Land Act it is possible that the National Park Service has no real jurisdiction. My information is that there is no place along the California coast where the intertidal marine life is protected.

So while we worry about mountain peaks, a great and very rich area of natural plant and animal associations, thousands of miles long and of varying width, is being lost.

In many ways, the wild lands can be a barometer for land use. Not only that, but they permit us to examine situations that have adjusted over a long, long time—longer than the existence of man himself. Just as the scientist can help the wilderness, it can aid the scientist by providing him with a variety of outdoor laboratories, where nature relatively unaffected by man has already determined the plant and animal communities best suited for growth and development, and where the dynamics of nature exist. I suggest that this value of wild lands has been scarcely touched, surely not to the extent that seems indicated in the future. Perhaps this is because our science has not advanced far enough to take full advantage of the opportunities, or more possibly, we have not set up the incentives or the apparatus whereby the scientist can effectively obtain, interpret, and apply his wild lands findings for the benefit of society.

Much has already been done in forestry, because timber stands do not ripen like corn in one growing season, so natural laboratories or check plots, if we may call them such, offer opportunities to study the natural processes which relate or can be related to forest growth. It has been noted by others that knowledge of original habitats (including of course the checks and balances of natural communities) can be important and save many years of work in learning what conditions favor pests and diseases. There are no natural checks left after a DDT spray! The natural factors, including possibly such insignificant things as the saprophytic fungi living in the soil and litter of the forest floor, might be important to the vigor of the forest and the determination of types and species. Then of course, the wilderness forest permits one to note, compare, and evaluate changes that occur outside as a result of exploitation and forestry practices.

If a man had decided to stake out a claim containing uranium ore instead of one containing lead, thirty years ago he would have been considered a candidate for the psychologist's couch. Not wishing to make the same mistake, who among us today dares to call worthless which animal or which plant or what interdependent group of them, developed by nature through the eons of time? Would there have been such a thing as civilization if all the puny grasses that were ancestors for our cereals had been wiped out because of some mixup caused by man? I wonder what course history and technology would have taken if the native rubber trees of South America had been chopped down and made into broom handles for Spain before any were moved to the Middle

East, Malay Peninsula or Indonesia? Can we calculate what the central European plain owes to the person who found a use for the ancestral white potato of the Andes?

Antibiotics, for instance, are not something invented by man. They did not come from a test tube. In nature's dynamic relationship, antibiotic substances are generated by many different kinds of fungi and bacteria. When man found out that penicillin, streptomycin, aureomycin, and other antibiotics produced by fungi were antagonistic to various pathogenic bacteria, he began putting the antibiotics into his own body and the bodies of his livestock to fight the bacteria there. Science has scarcely scratched the surface on the study of how species producing antibiotics utilize these substances to protect themselves. The field of, shall we say, antagonisms in nature is hardly explored. One would suspect that its benefit to man would have unlimited potential, and that what we have seen in antibiotics is merely a foretaste of the future. Algae, fungi, microörganisms, all sorts of life in all sorts of natural situations in sea or on land offer opportunities for the study of antagonisms produced as a part of the natural communities of living things and inseparable from them. Thus the scientist must work in the living community, where the interplay of nature is unfettered. Later on, it can be carried from the field to the laboratory for experimentation, perfection, and adaptation for use.

Man's mischief has extended so far that he now pollutes the atmosphere that he breathes into his lungs. The internal combustion engine, furnaces, blast furnaces, and the other manifestations of progress have done unpleasant things to the air, and radioactive pollution looms ominously, too.

It is well known that research is going on to find the extent and the effect of radiation upon organisms. It is known, in spite of necessary secrecy, that research has extended to wild lands in an effort to discover what has or might happen there. So here too the wild lands play their part as check areas free from the frightening pollution, or containing it perhaps. How is unaltered nature reacting to this, or what differences exist between the situation in the wild lands and country radically altered by man? With concern about heredity and mutation in connection with radioactive pollution, the importance of research and observation upon established and known natural plant and animal communities offers many opportunities.

These are but a few examples, picked more or less at random, in an attempt to suggest the importance of wilderness to science. It is certainly obvious that the relatively young science of ecology must have natural communities of living things upon which to base its inquiry. As we have seen, recognition of these natural communities represents something very important in man's understanding of his environment, an environment that must form the basis for his continuing civilization.

If it is possible to develop what I have called a distinctive wild land or wilderness literature, those who must make the plans and decisions on wilderness management will have better opportunities to be informed, and of course the values of wilderness to society will be made clearer. Our National Parks and Monuments are already profiting from research which will undoubtedly be more important in the years ahead, not only in park protection and enjoyment, but in environmental restoration as well.

Although our National Park System is an important factor in national cultural maturity, it is still not complete, and the supply of areas worthy of preservation as National Parks continues to shrink.

Erich Zimmerman, writing in *World Resources and Industries,* challenged us in these words: "The tacit assumption is that *homo sapiens* does not willingly spoil his own environment and that, on the contrary, cultural changes represent improvements in the natural landscape. . . . As civilization becomes more complex, however, the dangers of misdirected effort and poor judgment, and at times even complete lack of comprehension of the best interests of man increase. . . . The errors or lack of judgment may be due to inadequate understanding of ecology, to an insufficient regard for the future, or to the inability to master the growing complexities of world economy, but above all it is due to man's refusal to reconcile properly the conflicting interests between opposing groups and between the present and the future. Hence, what may appear as culture from the standpoint of short-run private property interests may *not* be culture in the light of long-run social welfare."

DISCUSSION

NED ROBINSON, *Discussion Leader*

STARKER LEOPOLD (Berkeley): I'd like to pose a question to Mr. Beard, regarding a very interesting point he touched on earlier: the possibility of managing wilderness areas. Specifically, I wondered, Mr. Beard, if you would comment on the Everglades in a little more detail than you did in your main address—the regulation of water levels and the use of fire as a management tool in the maintenance of that natural wilderness area.

MR. BEARD: As I said, concerning that particular National Park, there was considerable debate as to whether it should be a National Park, because it had been so badly abused. As a biological area, we felt it could be restored by natural means. The Central and Southern Florida Flood Control District—a tremendous big thing, which was written up in *Harper's* recently—is north of the Park. The natural flow of water into the Park is the ecological kingpin of the Park, and since I left there, they have made a careful research job on the water levels, trying to relate them to the flood control problem. As I understand it, it might cost several millions of dollars to attempt to get the same water conditions—the natural water conditions—into the Everglades, that existed before drainage. They are trying to do that, but it will never, never ever, become completely natural again. There can never be the same amount of water, flowing along the same channels in the same amounts, as there used to be. As I said, we are trying to approximate natural conditions. You mentioned burning in the Everglades National Park—your ears are very big—I didn't know that people out here knew about it. There is in effect a controlled burning program. The Caribbean pine lands were being destroyed, because there was fire climax occurring in that country long before man. That has been proved, and so, under certain predetermined conditions, these forests are actually being burned, in order to preserve the natural conditions. Otherwise, it would be completely an unnatural situation. That is a very interesting thing.

Ardis Walker (Kernville, California): This matter of burning is very interesting to me, and I would like to ask a question—or, perhaps, incorporate a statement with a question. I notice, in some of the early journals, mention of the fact that the Indians themselves set fires during the fall months, which would be comparable to a controlled burn. I am wondering if we haven't gone too far in the other direction, to the dangerous extent of allowing so much tinder and debris to collect in our National Forests, that we are committing slow suicide with some of our remaining timber stands.

Richard Leonard (Berkeley): I just want to remind everyone again of the very important point that Dan Beard made: evolution is still going on, and we shouldn't try to set a forest back at 1850, or 1900, or 1958, or 1959. I agree fully with Starker Leopold, and with Dan Beard, and others that we must determine what the lack of fire is doing to some of our natural landscapes. But I also think that we ought to consider whether it is necessarily bad to have a different set of species, or a different ecological growth and evolution, as a result of a lack of fire. We are certainly going to have fire in many, many areas, whether we like it or not. Some people have worried as to whether we would lose all of our fire-type chaparral of the Coast range, the Santa Lucias, and the Los Padres. Probably that will never happen, because, with the best control we can possibly get, we are always going to have plenty of accidental fires—as you can see in Malibu and other areas. But I think we ought to try to get some long range areas, over a number of decades or centuries, without fire and see what the changes are that occur in that way. In other words, we've got to consider nature as an evolutionary force.

Earl Bachman (U. S. Forest Service): Inasmuch as the use of fire in the National Forests has been mentioned, I would like to talk about it rather briefly. The use of fire as a tool is a very real thing in terms of land management. It can or cannot be used, as a land manager sees fit, in attaining his objective. But the first thing that must be decided, in terms of any land use, regardless of whether it is wilderness or what have you, is the objective itself. If, within the framework of that objective, fire can be used as a tool effectively, then it should be used. In terms of the National Forests, and the objective of their management, fire can be and is used as a tool very appropriately. For example, the Everglades country, the Southern forests, have been mentioned. Hundreds of thousands of acres are burned periodically in the Southern forests as a tool of management. On the West Coast, in California, there are hundreds of thousands of acres, in country that had once supported other than brush, in which fire can be used effectively as a tool for attaining the objectives of the management. There are many other acres, however, where brush is very critical in terms of the objectives of management, and where it should, in the judgment of the land manager, be continued and preserved in the condition it is in today. In these places, fire is not regarded as a suitable tool. So, it is a very difficult thing to generalize. There is a place for fire, and there are places where it should not be used, but it all ties right back to the basic objective of management in terms of the individual area.

F. Fraser Darling: I don't quite know where I come from at the moment—whether from this country or Great Britain. I would like to add a few words on fire in Africa, where the normal, accidental incidence of fire might be every one hundred years or every forty years, we scarcely know. It certainly isn't every year. But, at the present time, a very large part of Africa is burning every year, and it is quite obvious that degradation of the habitat is going on. Our friend in the Forest Service has just spoken of what you are trying to do by burning and what a useful tool it is. I have been quoted this morning as being very much against fire, but I do not at all wish to imply that it isn't a very effective part of the natural progression of the wilderness. But when, for example, our friend of the Forest Service said that we want to know exactly what we are doing by burning, he was thinking as a Forester of the increase in forest growth. But supposing, in a semiarid land, or one in which you get distinct dry and wet seasons, that the grasses there have arrived by adaptation to the phenomenon of translocation of the carbohydrate materials. From the upper part of the grass—the leafage—it goes down into the base of the stems and even the roots. Well, take a beast like the elephant. He comes along in the dry season, expecting to be able to whip his trunk around some of this grass, give it a pull up, give it a knock against his knee to get the earth off, and then to have a good chew of the carbohydrate food reserves left in the bottom. Then he throws the tops away. Now, what happens if you have had a burning program, which as in Africa at the moment insists on early burning, because it is less damaging to the flora? He is then faced, in the dry season, with having to scratch with his feet in order to get up these little bases of the stems, and it is very difficult for him to get his living in that way. He is, in addition, damaging his habitat much more by this scratching around with his feet than he would be by taking an occasional whip around and eating it that way. You do find that to decide exactly what you are doing by fire is very difficult, and that is why Mr. Beard is very timely in his explanation to us of the need for understanding communities, and what actually is going on within them and the need for understanding when we use tools to one end, what we are doing somewhere else. Thank you.

GEORGE MARSHALL (The Wilderness Society): It is indeed interesting, in a discussion of fire, that certain new dangers seem to be facing wilderness from the well-meaning manipulators who will burn part of the forests themselves but will put out the fires that burn through natural causes. I wonder whether part of the danger in burning isn't the fact that our National Park and wilderness acreage is much too limited. We don't have enough of these areas to withstand the burning of considerable portions of them. Formerly, and today as well, there is the other side to this whole fire thing—namely, the administrators' sense of responsibility for putting out the fires and their desire to get into wilderness areas (whether they be in National Forests, or National Parks, or where have you) with roads, and to build these roads right up to the crest of land at the edge of these areas, so they can jump in there with a lot of machinery to fight the fires. I think there is a problem there of calculated risk (if you don't mind that overworked phrase): can you continue to have wilderness and still use the amount of equipment that might be ideally necessary to suppress fire? I think that is an important aspect of this whole problem we have been discussing.

STANLEY A. CAIN

Ecological Islands as Natural Laboratories

Stanley Cain is one of today's leading plant ecologists. He has conducted research projects all over the United States (in Indiana, Tennessee, Michigan, and elsewhere) as well as in Brazil and in the Mediterranean Region. The results of these studies have been published in articles, papers, and books. Writing on "The Climax and Its Complexities," Dr. Cain interpreted and explained the theories of Frederick E. Clemens on "climax" and "success" in plant ecology. He is well known for the book *Foundations of Plant Geography*, and a *Manual for Vegetation Analysis*. Currently, Dr. Cain is a professor at the School of Natural Resources, University of Michigan.

The focus of this paper is interpretation—one of the most important functions of wildlands administrators. Dr. Cain asserts that by explaining the fascinating complexities of wilderness to the public, such agencies as the National Park Service can increase public appreciation and enjoyment of the wilds and so spread the conservation spirit. The knowledge requisite for effective interpretation must be gathered through research programs substantial enough to expand valuably the ecological and biological sciences themselves. It is important that administrators set for themselves these two goals: scientific research and public information.

I DO NOT KNOW of another conference that has addressed itself to the scientific value of the wilderness. This is an appropriate and important theme, as so little remains of this essential source of information. My title refers, in fact, to the remnants of wilderness, protruding, like the mountains of a sunken continent, out of our civilized ocean.

Many of us are caught, by stating that the wilderness must be protected because of its value for scientific research, in an apparently untenable position. We are unable, in a given situation, to point to any significant research already performed in the wilderness tract under question. One wins no adherents to the side of protection by saying only that someday, someone will want to study something in the wilderness, that it might be important to do so, and that it would be a shameful loss were the wilderness no longer in existence. I believe this, but it does not provide a stout verbal cudgel. However, before saying more about the wilderness as a natural ecological laboratory, I want to use my license as an invited speaker to make two or three preliminary points.

I would not, in defending the wilderness, try to compete with the dollar values of the market place. The columns of marching pines, that shoulder the mountainside in sunset silhouette, do not add up like the columns of dollars for board feet of lumber. The leaping trout of white-water streams cannot compete with the price of kilowatts of hydro-power, or the tons of sugar beets, or bales of cotton that could be grown on lands irrigated by impounded streams.

One believes in wilderness, or he doesn't. In your heart, you know its value, or you don't. You can add up all of the expenditures of wildlands recreation: for arms and tackle, for gasoline and meals, for cameras, licenses, boats, and fancy clothing; they amount to billions of dollars; yet the economic argument has never saved a single wilderness nor justified the saving of one. This is true for the simple reason that the economic argument cuts both ways. If your appraisal of the wilderness is made on an economic basis, all that has to be shown is that the dollar value of timber, or minerals, or impounded water is greater, and the wilderness value has been superseded. To put forward the economic argument for appropriate kinds of wilderness recreation is to put the wilderness on the block, for sale to the highest bidder.

I am trying to make it clear that I don't believe it wise or necessary, or that the public requires, that the wilderness be given economic justification. I am not saying that it is unimportant that perhaps one per cent of the gross national product is derived from expenditures connected with wildland recreation. Of course that is important! I am saying, rather, that the wilderness, broadly interpreted, would be valuable and its preservation justified even if it contributed nothing to the gross national product.

Another point, sometimes embarrassing to defenders of the wilderness, is that relatively few persons ever penetrate it on foot, by packtrain, or canoe—the vast majority see it from automobiles or from points of tourist concentration. Last summer, in Michigan, an Interim Legislative Committee, and the Conservation Commission, held some hearings on the question of copper mining in the Porcupine Mountains State Park. Locally, this was as hot an issue as Echo Park. Some bitter debaters publicly stated that only "odd balls" and "out-of-doors" writers ever went into the wilderness; anyway, you could put a million people in this State Park wilderness and they would never see each other. (This might be true if you hid one behind each tree.)

But this argument, like the economic one, misses the point: you can't defend wilderness by counting noses, just as you can't justify the Corcoran Art Gallery or the Library of Congress by comparing the number who go there with the number who go to the Rose Bowl or the number who watch "Gunsmoke" on Saturday nights. You see, these are incommensurables.

We are confronted with a pluralistic society with many value systems. Rather than economic values, which have a proper and important place, or our inclination to evaluate things by size or number, I speak now of quite a different sort of value. The sociologist Robert Angell has said: "Serenity is a vanishing quality of life . . . the world presses in upon us, insistent, confusing, often tragic." If this is happening, and if, as many of us believe, a sojourn in the wilderness has restorative powers for moral and social equanimity, then what other reason do we need for the preservation of wilderness and for its protection?

You might say—it has been said—that this is essentially an aristocratic, actually snobbish, approach to the wilderness. We are saying that there is a minority of people, an élite, that can and will—physically, mentally, and psychologically—be able to enjoy this wilderness. Well, perhaps this is an aristocratic approach—but the snobbery that is involved is not that of family, or position, or utility, or concept of progress; it is based on taste, on quality, and sensitivity; it is based on reverence for nature and knowledge of it. We would weaken such an esoteric argument by entering it into competition with other value systems. Nevertheless, we do a disservice to it anyway, if we fail to put it forward, stoutly and frankly.

Wilderness areas, I think, are of higher usefulness to man when left alone than when they are utilized for goods and services that have dollar value. So far, I have not dealt with the problem as a scientist, but more as a humanist. But this is not just my position, nor that only of us here at the Sixth Biennial Wilderness Conference. It is the position of a great many people who have similar tacit standards as to what "ought" to be, as far as wilderness is concerned. There were thousands who objected to the destruction of the Porcupine Mountains Wilderness for mining. There were hundreds of thousands who objected to flooding Echo Park. And hundreds of thousands—perhaps millions—would get fighting mad if Yellowstone or Yosemite were to be commercially exploited.

Rather than producing a lengthy polemic on wilderness preservation, I want to move on to my subject: the value of wilderness as an ecological laboratory. I will not claim that natural scientists need outdoor laboratories where they can work undisturbed. This is important, but it is not most important in this context. Nor will I say that wilderness research will shatter our ignorance or promote a revolution in scientific understanding. I do not expect another Charles Darwin to emerge from the dripping Olympic forests, nor from the prickly desert at Joshua Tree. I do not expect a new geologist like Dana to come out of the Grand Canyon, nor a Margaret Mead out of Mesa Verde. My point is this: the wilderness should be studied to enhance enjoyment—the enjoyment of people who are interested in wilderness, who visit, love, and cherish it.

Why do so many tourists drive to the National Parks and Forests—or to any other wild land reservations? I think that the motive is appreciation of nature: each man to his own degree and with wonder, according to his own capacity. If this is true (and proof is impossible) then the interpretation of nature to the public is the most important function of wilderness administrators.

The American public has adequately demonstrated that it wants the wilderness left alone. It appreciates the wilderness, even at a distance. A small percentage penetrates the wild, to be sure; but there are hundreds who learn something about it on guided nature hikes, and at information centers, and by listening to campfire talks. There are also the unknown numbers who get some, and often much, pleasure from magazine articles and books, from nature lectures and Disney films. This is the tremendously large public which is receptive to natural history information about the nation's wilderness areas. These are the people who read *Arizona Highways*, attend Audubon lectures, and follow the outdoor and travel pages of newspapers and magazines.

I believe that there is a vast audience for nature interpretation that is inadequately addressed, despite the fine work already done by Park naturalists. I think that this is true because there is no adequate program of research designed to feed into the interpretation program the necessary and appropriate facts. I am thinking especially of the National Park Service, because of its responsibility for our most spectacular and precious remaining examples of wilderness, and because it is only the National Park Service that has legal responsibility for the protection of the entire environment and all that lives in it. Of course, roads, camps, and other facilities are necessary for public use while the land and the people are protected, but the obligation of the Park Service can't stop there. Housekeeping is necessary, but it still is only housekeeping. I believe that the central function is that of interpretation. I believe this because I believe that interest in natural features of the Parks is the principal attraction of them for the public.

I don't mean to say that the people of the United States are nature lovers ostensibly. The British, for example, are much more frank about this than we are. They have their Snail-watching Society and their Friends of the Trees. But I do think that American foolishness with bears is less the result of stupidity than of curiosity about the animals. One might ask, of course, "How curious can you get?" The Chief Naturalist at the Smoky Mountains saw something ahead of his pickup truck that almost made him drive off the road. A lady was seated behind a wheel, and a bear was halfway in the front door of the car. Papa was pushing on the bear's rump, trying to get him on the seat for a group picture. Submerged appreciation for nature is popular in Michigan: lots of hunting, lots of fishing. That is, our own people and people who come in (the Tourist Council interrogates them at check points) say they are going fishing. That is something respectable. But, you see, they are going outdoors to enjoy nature; that is what they are doing. Sometimes they fish a little bit. In Michigan they give up pretty quickly on that! There is pretty good evidence that many a hunter is less interested in the chase and the kill than he is likely to admit: deep down, he is more interested in his woodlore and his knowledge of the habits of animals, and of terrain and weather, and his sense of relatedness with nature.

So, to return to the point, I think that the National Park Service is missing a bet. It lacks an adequate research program of its own to shore up its interpretation program. And so, today, I am speaking not only about the National Park Service, but to it as well. What I want to do is to promote a wider, deeper, more adequate research program, particularly in biology and ecology, by the Park Service itself. To make such an effort effective (and I tried it some years ago without producing any effect) I needed to know the attitudes of those who made policy for the Service. The result was that I telephoned Mr. Ronald F. Lee, Chief of the Division of Interpretation, and found him so interested that I flew to Washington to talk with him and his associates, Mr. Scoyen and others. I needed to know how much interest, if any, existed in basic natural history research. I needed to know also whether outside pressure and cooperation would be welcomed. Happily, there is, at the Washington level of the Service, a real interest in basic research, and a warm receptivity to suggestions, cooperation, and even pressure from the outside. I conclude, therefore, that it is possible, for those of us who may be interested, to be of real help to them—they would like to do a great deal more of their own research than they have been able to do.

Now I should take some time to describe the program of the NPS, in terms of research. Their Annual Reports provide the best summary of the scope, as well as the limitations, of the program. Following is the statement about research from the Annual Report for the fiscal year ending on June 30, 1957:

> In the National Park Service research is one of the important means which enable it better to meet its responsibilities. Historical research is done largely by its own historians. In other fields it is accomplished in various ways. Service employees contribute importantly to it, but it leans heavily also on the cooperation of other Federal agencies, and publicly and privately supported institutions of higher learning.
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> During calendar 1956, 160 research projects were performed by regular and seasonal members of the Service, collaborators and cooperating groups and individuals. Of these, 148 dealt directly with the areas administered by the National Park Service, four were in the category of investigations of proposed areas, and eight were general research projects. Graduate students and staff members of twenty-three colleges and universities, and four private individuals participated in these projects. Five Federal agencies, seven State agencies, and three professional societies also performed research or assisted field personnel in research projects.
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> Natural science research during the year dealt with such matters as siltation at Mammoth Cave National Park, the ecology of Florida Bay, in Everglades, hydrothermal phenomena at Yellowstone, and the ecology of high mountain meadows and other fragile environments in several National Parks. The Coastal Studies Institute of Louisiana State University and the Office of Naval Research cooperated in detailed research on the geology, botany, archeology, and history of Cape Hatteras National Seashore; North Carolina State College is doing further research there in biology. Seven major geological research projects were in progress in Death Valley National Monument alone.
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> Texas A.&M. College and the Texas Fish and Game Commission are participating in a five-year study of Big Bend National Park ecology. Biological and geological studies are underway in Virgin Islands National Park, with the University of Kansas and Princeton University cooperating.
>
> Historical research included studies of the appearance and use of Independence Hall at

various periods; of details of colonial life and land ownership at Jamestown; of the locations of specific features at Fort McHenry (a necessary basis on which to prepare development plans) and a study of the historic structures remaining at Harpers Ferry.

Archeological methods were employed at such historic places as Fort Frederica and Fort Union National Monuments, at Jamestown, at Independence and Cumberland Gap Historical Parks, and, on a minor scale, at a number of other areas. Important archeological research was continued by the University of Colorado at Mesa Verde, by the University of Southern California at Death Valley, by the University of California at Yosemite, and by the Bishop Museum of Honolulu at the proposed City of Refuge National Historical Park. Washington University, St. Louis, cooperated in the effort to find the original site of Arkansas Post. Service archeologists excavated at the site of Fort Clatsop, in Oregon.

Under cooperative agreements, sixteen universities and colleges and the Smithsonian Institution performed river-basin archeological salvage. In addition, the University of Utah, the School of American Research, and the Museum of Northern Arizona undertook such a salvage in the Upper Colorado Basin. The Smithsonian, working at eleven reservoir sites with funds supplied by the Service, recorded more than 200 new archeological sites, excavated nineteen, and processed more than 179,000 excavated specimens.

The Annual Report for the fiscal year ending June 30, 1958, adds that historical research has been inaugurated at Harpers Ferry and Fort McHenry, and that the archeological salvage program for basins about to be inundated was extended to the Glen Canyon and Navajo Indian Reservoir areas. A program of alpine wilderness research and a project on the biology of the United States Virgin Islands were initiated, and a research conference in Everglades outlined needed studies. The Division of Interpretation was given specific responsibilities for developing the biological research program, by stepping up Service-conducted investigations and encouraging cooperative research by qualified scientists and established research institutions.

In effect, the program amounts to this: the National Park Service has used its very limited funds primarily to stimulate, to catalyze, and sometimes, in a small way, to assist research. They have used their good offices to encourage cooperation, and in some cases work, by the Geological Survey, the Fish and Wildlife Service, and the Forest Service. Many universities, many private investigators, some organizations cooperate with the National Park Service. But, when you add up what they describe as their research program, and subtract from that the work they do in historical research, archeological salvage, and a few odds and ends, you find, in the biological field, that what they are doing is investigating the conditions which surround a critical problem. Their research is—and has been of necessity—directed towards "trouble shooting," as Mr. Beard admitted earlier this morning.

Now this does not mean that during years past there was not some very significant biological research accomplished by Park Service biologists. I would mention Adolph Murie's *Ecology of the Coyote in the Yellowstone* (1940) and *The Wolves of Mount McKinley* (1944). These were bulletins in the Service's *Fauna Series,* which has been inactive now for more than a decade. The study by Coleman Newman, forester in the Branch of Park, Forest and Wildlife

Management, of the *Roosevelt Elk of Olympic National Park,* is an example of a recent Service-staff investigation that deals with basic biology. As an outstanding example of cooperative effort between the National Park Service and several other agencies, I would mention Carl B. Koford's wildlife monograph, *Prairie Dogs, Whitefaces, and Blue Grama* (1958). The Service facilitated Koford's study by appointing him a Collaborator, giving him access to Service studies and maps, and by active assistance of Park personnel. Service personnel in the Division of Interpretation have, in many cases, contributed fundamental knowledge of the fauna and flora of the Parks where they have been stationed, as in the case of Arthur Stupka, Chief Naturalist of the Great Smoky Mountains National Park. They and their Park Superintendents have aided materially the research of many independent scientists. They have often been graduate students gathering data for their Masters' and Doctors' dissertations. A recent example is that of Grant W. Sharpe, whose Ph.D. thesis was *A Taxonomical-Ecological Study of the Vegetation by Habitats in Eight Forest Types of the Olympic Rain Forest, Olympic National Park, Washington.*

Such a review of research activities which are carried out or facilitated by the National Park Service is, of course, not complete; but I do not believe that it misrepresents the situation. I must conclude that the National Park Service does not have a program of basic research. These things are fine as far as they go; but they fail to approach at all closely a program adequate to the needs of the Service itself.

The first difficulty, as I see it, is that the research activities of the Service are directed toward immediately pressing problems. I will illustrate this point by reference to the program of *Ecological Research in the National Park Service on Alpine and other Wilderness Environments.* The following statement was used in justifying the appropriation of funds (described as modest) for the initiation of the ecological studies:

> Increased visitor use of alpine and other wilderness areas in the Parks presents special problems of a related nature. The alpine meadows, which if once destroyed are irreplaceable, are particularly vulnerable to disturbances caused by man, and the unique wilderness values in the 'back country' of these Parks generally require special attention. Studies on the ecology and the fundamental requirements for protecting these features are urgently needed.

Research contracts were executed: with the Institute of Arctic and Alpine Biology of the University of Colorado, for studies at Rocky Mountain National Park; with the Jackson Hole Biological Research Station of the University of Wyoming, for studies at Grand Teton National Park; and with Dr. Carl Sharsmith of San Jose State College, for studies at Sequoïa-Kings Canyon National Park. In addition to Dr. Sharsmith, project supervisors and investigators include Doctors John W. Marr, L. Floyd Clarke, Charles C. Laing, and Beatrice Willard, all accomplished field ecologists. The purpose of this program, which may be extended to Yosemite, Mount Rainier, Olympic, and Glacier National Parks, is:

> To determine the visitor impact on Park vegetation by studying sections of the Park which have been receiving extensive visitor use and by comparing these sections with portions of the same type which have received a minimum of visitor use. This would permit investigations of alpine meadows and other wilderness areas to determine the ecological status of fragile plant communities and to ascertain the basic requirements for their protection and perpetuation.

This is ecological research, but it is directed at "trouble shooting." It is programmed, and it will yield scientific information about alpine communities, but it is directed toward the needs of management, not toward the needs of the interpretation program. It is directed toward a specific problem which has to be corrected now if great damage is not to be done.

I have no quarrel with such research. It is necessary. It follows an established Park policy of management, first enunciated in 1939 by Ira N. Gabrielson, and approved by the Director of the National Park Service and the Secretary of the Interior: "No management measure or other interference with biotic relationships shall be undertaken prior to a properly conducted investigation." I now turn to a suggestion of what, in my opinion, would be the ingredients of a National Park Service program of ecological research. I think you will forgive me for limiting myself to biology, in the ecological and geographic senses, rather than talking about what might be needed in terms of geology, or history, or archeology, or any other field.

It would be presumptuous of me to state in detail or with finality what a basic ecological research program should include. I will do no more than discuss briefly some of the matters which could be given attention and for which research would yield information directly usable in the interpretation programs of the Parks. That such investigations might have general interest, constitute contributions to basic knowledge, or to the advancement of scientific understanding or theory, would be no more than a fortunate by-product from the point of view I am stressing.

I believe that every National Park should have a continuing program in faunistics and floristics with suitable museum and herbarium vouchers for the species claimed to be present in the area. Many species are critical of identification, and the very existence of these vouchers will, in any case, permit scientific comparisons and possible revisions at some time in the future. Such knowledge would be built up over time and would run the complete systematic gamut, including, for example, small mammals as well as large, mollusks as well as fish, mosses and lichens as well as trees and conspicuous flowers. Such knowledge is basic to everything else.

Now the thousands of species of plants and animals do not occur in an area by chance agglomeration; Dan Beard talked very well about this this morning. Every Park should program a basic description of the composition and structure of its vegetation and of the animal life closely associated with the vegetation. This would be a modern technological way of organizing information according to the existing natural plant and animal communities. It would start with the major cover types and include the lesser, but interesting and important, communities of special habitats, such as hot springs and serpentine rock outcrops. How are the component species organized in layers and other synusiae? What are the dominants? What are the indicator species of high fidelity to a given community and ecological situation? Having gained information on the morphology of communities, the Service should then direct investigation to their ecology. What is their pattern with respect to altitude, slope and exposure, to microclimate, and to the conditions of the substratum? What are the important actions, reactions, and coactions in each community? The result of all this might be a map of some scale or a series of representative maps at different scales. Texts would complement these and would have the quality of consummated work, so that the project would stand up in any international circle as being a justified and magnificent piece of description.

People are interested in biogeography. There is excitement in knowing that a certain plant or animal is endemic and lives naturally nowhere else in the world or that, in a given area, it is disjunct, perhaps hundreds of miles from its main range. (Most species will be found intraneous and well within their full range, but many species are extraneous, at the place under consideration, and characteristically range northward or southward, eastward or westward, toward the coast or toward the mountains.) These irregular occurrences bring up matters of historical biography: where are the ancestors of the endemics and where are their relatives now? How did the disjuncts get to where we now find them? But begin with the basics: what is an endemic? what is a disjunct? how did the disjunction develop? how can you have relics both of cold and warm climates in the same place at the same time? Then, what are the dynamics of movement in time: migration, evolution, extinction? In most parts there are some fossils, and this brings you to an interpretation of fossils in relation to the life that exists—not now, in the place you are talking about, but perhaps it existed, or may exist today, somewhere else in the world.

Life histories should be studied, not only of species causing management problems but of those which are interesting for any reason. How is the life cycle carried out? Through what stages and with what relations to the environment? What are the diurnal and annual aspects of the life activity?

These matters, so briefly suggested, are basic. They ask the question: what is there? They ask what the conspicuous community arrangements are, and they go to the point of especially interesting life cycles and biogeographic features. Every interpretation program should be backed up by an abundance of information about such natural history matters; such studies may not be on the frontier of scientific advancement, but they are eminently respectable and very practical in the National Park situation.

I will speak now of biological studies that can be made in any wild land area to produce information with public appeal that goes beyond the names for species and the knowledge of communities. In each case the examples should be local; that is, they should deal with plants and animals in the area where the interpretation effort is being made.

What about rare or vanishing species? Why are they in danger of extinction? What actions are necessary to protect them and to give them a chance to recover reasonable numbers? Why worry about extinction anyway?

What are the regional prey-predator relations, food chains, and pyramids of numbers? And, related to these in some ways, what is the nature of territories, ranges, and home ranges? Why must some wilderness areas be as large as they are? What is the concept of carrying capacity of land for given species? And what is the relationship to population size and density and to habitat deterioration? What are population cycles? What causes them? How do they relate to prey-predator relations and how to producer and consumer relations? What are epidemics and infestations? What are some of the problems in a National Park in disease and pest control and in the control of other populations when the balance of nature has been upset by reduction of predators or when influential changes occur outside the Park and beyond the Service's management?

What is the nature of community dynamics? What is succession? What is the nature of equilibrium in nature? What is a climax and what are the climaxes of a given region?

Why do species of a genus have the patterns of occurrence that they do? Why are the most closely related species of a genus allopatric in their areas and only the less closely related ones sympatric? What is the nature of some of the barriers to hybridization? What are clines? What is the subspecies as interpreted by mammalogists and ornithologists?

Now the National Park Service places great confidence in its interpretation program. It spends considerable amounts of money in developing visitor centers and museums and in employing people to do the interpretation on the trail, in the museums, in campfire talks and in writing. What I suggest is this: this central function of the NPS—its interpretation program—is dependent for its information on the happy chance that some other Federal agency, or some State agency, or some independent institution, or some broken-down professor, happens to have done something in the National Parks in the way of basic research. This, in my opinion, is no way to run a railroad. Many people will patiently sit looking at a few dozen slides of spring wildflowers, or nesting birds, or scenery, and have a good time—if the photography is good. But wouldn't they have a better time, an exciting time, if the intellectual content of the presentation were not static and at the level of "what is it?" or "where is it?" If the Park had a research program to provide a foundation for its interpretation program, then it could say: "Emphasize ideas, not things"; its program would be a vital one, and the customers would profit from their travel expenses.

Here, as a postscript, is an excerpt from a telegram I received. I sent the NPS in Washington a copy of my speech, and this is their response:

GREATLY APPRECIATE OPPORTUNITY TO REVIEW YOUR PROPOSED SPEECH AT WILDERNESS CONFERENCE. WE LIKE IT AND WELCOME CONSTRUCTIVE CRITICISM AND SUGGESTIONS. WE WANT TO DEVELOP BASIC ECOLOGICAL RESEARCH PROGRAM ALONG LINES YOU DESCRIBE AND WILL DO SO AS RESOURCES PERMIT.

There is more, but that is enough. The NPS needs a burr under its tail. They have money, but they have not been spending it properly. This, of course, is a question of policy; here, we have an issue.

DISCUSSION

NED ROBINSON, *Discussion Leader*

KENNETH MCLEOD (Consulting Forester): As an efficiency expert, I am interested in the problem of mental fatigue—a prevalent malady, now that machines have made it easier on us physically. Perhaps the wilderness is important as an antidote to this mental fatigue, a problem of increasing intensity in America and the source of many new problems. And in this context, who is studying the most important animal of all—genus *homo sapiens*?

DR. CAIN: About a year and a half ago, I made the suggestion that the State Department of Conservation in Michigan, which investigates fish, wildlife, forests, minerals, oil, and everything else but its customers, should have a small branch consisting of persons who were competent in statistics and in the methods of social science research, such as survey techniques and design of questionnaires. This seemed to be an attractive and somewhat new idea, but the answer was this: what the Department of Conservation now says is already suspect, and if we make comments on the people's motivations in using our Parks, we will be even worse off. They said we should employ people from the University, or someplace else, to make these studies for us; then they will be acceptable to our critics. You see, this again is a weak and rather untenable position; I think that every organization should study its consumers as much as its products.

EDGAR WAYBURN (Sierra Club Director): Both of today's speakers have addressed themselves to problems which apparently pertain to the National Park Service alone. I would submit that these are not problems just for the National Park Service; these are problems of the natural terrain of America which need to be seen in a wider aspect. We have other jurisdictions which have control of the natural landscapes and which must classify, for one purpose or another, all of the lands remaining in the natural state. I wonder if the things that have been said don't point to one basic need at this particular time: the need not to classify for use so much as to classify for the present existing circumstance. One can always use these areas whenever they are needed; one can't un-use them when they are no longer needed. It was pointed out earlier that we have the capacity to reconvert to wilderness status some of the changed areas. Conversely, we cannot reconvert other areas, and the span of time necessary for this conversion and the amount of time, energy, and money which is required, is bound to be prohibitive. It seems to me that one of the purposes of conservation is to save perhaps a little more than we need to at the present time—perhaps for limited spans of time, just to be sure that we are not wasting too much.

DOROTHY VARIAN (Cupertino, California): The interpretative program of the NPS must be a real problem to the Park Naturalists because of the hordes of people. My husband once told Lon Garrison that the way to solve the traffic problem in a National Park was to set up a small naturalist booth or information center at the entrance way to the Park, and then all the people who collect windshield decals and folders about the Parks could just collect them and not go into the Park. This would save a lot of trouble.

On the other hand, those who do get into the Park, I think, depend upon this interpretative program for the tiny capsules of knowledge that they take back with them. The ability to make these interpretative programs dramatic, something that you can grasp, that you can photograph and take home and talk about, is the means by which information about our National Parks really spreads through the large mass of the touring American families. And I feel that it is just this tiny bit of natural history that the people take back that gives us the foundation with their children for an understanding of the wilderness in the future. The majority of parents who take their children may be seeing it for the first time—their youngsters may go back later and be interested in what they see. The one thing that has bothered me about the interpretative programs of the Parks we have visited has been their similarity. You will look at one interpretative program and you will very likely see its similarity to another, so that you don't realize or appreciate the geological or ecological differences that may exist in those Parks. Dramatizing, I think, is very important in making our young people understand and remember a little bit more.

Charlotte E. Mauk (Berkeley): I think one of the things we have to keep in mind in an interpretative program is what we want to achieve beyond having a person understand something of what he sees. We want to give him, through his understanding of it, a feeling that this is something that belongs to him: he has a personal stake in it; he has made it a part of himself by understanding it. Therefore, he is ready to protect it against the things that might keep his children from going back to visit the wilderness.

Paul Zinke (School of Forestry, University of California): I would like to describe a program which the California Division of Beaches and Parks has instituted in the way of research on natural areas. They have the problem of maintaining many large old growth redwood groves in the North Coast Range in what people feel would be a natural state. Well, these trees do not persist as long as one would think, and when one goes into these groves he finds that many are dying, falling, and decaying in different ways. But the Park Foresters who are entrusted with the objective of land management there, of maintaining the forest in a natural condition, really have a problem on their hands. First they have had to define just what a natural condition is, and then they have had to find out what the impact of people is on this natural condition, and thirdly they have to find out how to institute management in this area to soften this impact on the so-called natural condition. Well, they found they did not have the basic ecological answers to much of this or enough knowledge about these forests, and so they have brought about a research program through contract with the Wild Land Research Center of the University of California, which is involved in investigating the ecology of these redwood stands. This is one way in which this type of research can be done by agencies administering natural areas: through contract research with other groups or by members of their own staff doing the basic research that is necessary for the land managers they hire.

Marietta Voge (UCLA): Since this is a matter of concern not only to the Park Service but also to all the inhabitants of the United States, what are we doing in our public school systems, where we can begin early to train children, to tell them about these things? What are we doing in the way of suitable propaganda?

Mrs. Peters (San Francisco Town Council): I have just travelled 4,000 miles in two months, studying this proposition of controlling the school children and what to do to keep them interested. The most interesting place I found was Fort Worth, Texas, where before a child enters the museum, he first has training in how to behave. There was no mess in that beautiful museum; there were no disturbances. I went there various times and hundreds of children went through. It was the most worthwhile program I found in the 4,000 miles. Many people here get the bulletins from this museum and know of the splendid work they are doing.

Pearl Chase (California Conservation Council): This is to the photographers and lecturers. I find that we spend an hour and a half's interpretive program—after we have paid sometimes a good many dollars for hiring these people to spread the news of the wilderness in the beautiful parks of our country—and not one word of conservation. It is all about the scenes, not about the reasons for saving them. And if we could just give those men a little more of that spark, it would reach thousands within this country. That applies to the Audubon tour men, as well as to others I've heard.

NED ROBINSON: I think you are right: many of us have a tendency to say: "this is a beautiful area," without mentioning the possibility that it might not be here at some future date. We can look to ourselves to improve our own lectures and thoughts.

MRS. NEIL HAIG (Seattle, Washington): This program for the children is one I have been very much interested in myself, and I have found through investigation that school children know very little about conservation as such. For instance, the Virginia School Department made a survey of the children, and only fifty per cent knew anything at all about conservation. And just before I left I received a letter from the Dean of Education at Helensburg State College, who says the best way to reach all of the children is to give every teacher before she goes out into the schools a complete knowledge of conservation in all of its aspects. They cover many fields of conservation—water pollution, trees, soils, erosion, etc.; but they do not say anything about wilderness or National Parks in their conservation programs. I have looked at many of the books, and there is nothing about those two phases of conservation. They are the things I think we should make an effort to put forward in all the school systems of the country.

DR. FRANK PITELKA: First, just two brief comments underscoring two points which Professor Cain made. Reference has been made to redwood groves and the problems needing research information. I would like to tell you about an occasion three years ago at a meeting in the East, when I was at a lunch table with Professor John T. Curtis, Plant Ecologist at the University of Wisconsin. He teased me: he said, what is the matter with you people out West? Believe it or not, there is nothing in the botanical literature of western North America which will give you a rundown on the structure and composition of a redwood forest at the level needed by a teaching plant ecologist. Surely this is one need which can be filled by the sorts of activities that we should like to see the National Park Service participate in more. That is one point.

Professor Cain also mentioned the interest in biogeography, and I would like to tell you about an occasion in England last year. I spent the year at Oxford University and had occasion to work in the field with Charles Elton, who is very much interested in the same sorts of problem from the British standpoint. He took me to one spot, northwest of Oxford, which is a nature area set aside after some debate apparently because of the difference that one little bit of factual information made. This bit of factual information was the occurrence on this area of a flatworm, a small, short, black flatworm, difficult to see, that occurred in one particular spring and nowhere else in the region. It was a species of flatworm which otherwise only occurs far to the north, and it is, in other words, a relic which hangs on at this particular spot because of the peculiar condition in this spring. And Mr. Elton was amused at the effectiveness of this little speck of circumstance, which seemed to swing the authorities with regard to the question of buying the place. There were other justifications, but he felt that this little bit of biogeographic information and the uniqueness of this spot because it had this flatworm did make a very big difference. And I do believe that I agree with Professor Cain that information of this sort can be exploited very effectively.

Finally, Professor Cain referred to the British interest in natural history and he felt, if I understood his remarks correctly, that although the Americans don't behave as the British do with respect to the study of birds, etc., their motivation is basically the same. But we ought to examine, instructively and constructively, differences between us—between the reactions of the British and the Americans with regard to subjects of natural history. I would say, that although the motivation may be the same, the performance obviously is not. And if you think that the people going out into the field in America do so for the same reasons they do in England, one fact surely remains: at this time in England, nature conservancy and the scheme of natural areas they have set up have reached the stage of research effort which is precisely the thing we are setting as an ideal for ourselves here. And I would welcome comment from Professor Cain and perhaps from others who know the British system on this particular point.

Ned Robinson: Dr. Cain said he was speaking as a human being when he was talking about the arguments for conservation. He was also speaking as a person well schooled in logic. As an individual who makes a living trying to argue at times, I find myself shuddering as I hear some of my conservationist friends trying to answer arguments of those who say: "what is the economic value of wilderness?" or: "how many people went down through Glen Canyon?" And rather than say: "this isn't the argument; the argument is something to one side," they fall into this trap beautifully. I would like to reinforce this comment: when you are talking to people who are not too happy about wilderness, and they bring up "have you stopped beating your wife?" arguments, meet them with our own arguments. The best defense is a good offense.

LUNA B. LEOPOLD

Ecological Systems and the Water Resource

Luna Leopold combines the mathematical and naturalistic approaches to science. He was trained as an engineer at the University of Wisconsin, became a geology Ph.D. at Harvard University, and studied meteorology at UCLA. With this preparation, he created a new school of river morphologists. A fundamental paper on hydrology, "Hydraulic Geometry of Stream Channels and Some Physiographic Implications" (1953), earned him last year's Kirk-Bryan Medal, awarded by the Geological Society of America. He is now Chief of the Water Resources Division, United States Geological Survey.

Nearly all environments are not only altered from their original states but are also constantly undergoing still further change. The impact of man upon nature is great: "There are very few areas, except in the special hydrological environment of some mountainous terrain, where one could follow groundwater changes due to natural causes alone." Until man and nature are statistically separated, the actual influence of standard water resource "improvements" is incalculable, and the development of new and more efficient techniques impossible. Dr. Leopold outlines here a program of bench mark hydrologic stations as standard bases for datum points. He contends that the proposed system would be invaluable for distinguishing natural changes in the water resource from those induced by man.

IN ANCIENT SPARTA there were two principal classes of people: there were the so-called citizens and the helots. The citizen was trained primarily to be a warrior. The helot, a serf, was the tiller of the land, but he could also be called to military duty. The history of Herodotus makes it amply clear that war was the biggest business of the times. Because the Spartans were always marching off to war, they found the land-bound position of their city, located as it is in a small central basin nearly surrounded by mountains, somewhat of a disadvantage. When they were under attack, of course, this situation was a favorable one inasmuch as a sea-borne enemy had to march inland to come to grips with the Lacedaemonians. But the relatively small size of the independent states meant that the Spartans had no direct access through their own lands to the sea.

There is evidence that the Spartans reached an agreement with surrounding states concerning a free corridor. There would be maintained by all the Grecian states of the Peloponnesus an access route, stretching essentially from Sparta to Corinth, and through which a marching army could have access to a seaport. As a secondary benefit this "no-man's land," which in our Western lingo might be called a stock driveway, allowed merchants and their caravans to move freely between the flourishing trading port of Corinth and the inland cities to the south and west.

Apparently, one condition of the agreement between the states with regard to the use of this access zone was that there should be no permanent agriculture or grazing in the driveway. As a result, through several millenia B.C., during which there was high population density in the Aegean area, one strip of land was exempted from the pressures of grazing, lumbering, and agriculture which characterized most of the rest of the landscape. And even today, this driveway maintains a forest cover. In contrast, nearby mountainsides with even larger annual rainfalls support hardly a tree.

It is not entirely apparent (and certainly I cannot answer the question) why subsequent centuries did not see this area denuded. But even with the scanty details known to me, it seems clear that the peculiar history of this one area potentially offers us a greater insight into some aspects of the forest and land conditions in classical times than all the extant written records. The several references to sources of timber and cutting of forests which are contained in the vivid chronicle of Herodotus are valuable, but they lack species identification for the most part. Though rich in human understanding and psychological insight, his history strongly resembles, in my opinion, the travel sagas of the Spanish Conquistadores of our own Southwest who had no real eye for "country." Even a careful reading of these early travelers—Coronado, Garces, and Espejo—gives us no picture of the nature of the country, its vegetation, the conditions of its rivers.

To describe a biota there is no substitute for a sample. But it is logical to ask, what might one want to know which would require the preservation of a sample? Whether such a question is asked at all is a reflection of the stage of intellectual maturity of a civilization. We take it for granted that there is some social gain in the erection and maintenance of a museum of fine arts, a museum of natural history, or even a historical museum. Sooner or later we ought to be mature enough to extend this concept to another kind of museum, one which you might call the museum of land types, consisting of samples as uninfluenced as possible by man.

Now I am in complete agreement with Dr. Cain's remark, that the way to measure the value of a piece of wilderness is not by the number of people who use it. He went on to say that the best justification may not necessarily be the research that we are going to do on it. But there is evident in these days of disappearing wilderness a constantly expanding social awareness of the importance of science for maintaining and developing further society itself. We seem to sense the intellectual as well as the economic advantages of exploring the moon and outer space, but we still have corners of our own backyard which we are going to clean up and make neat as a pin without realizing that much might be learned there if only we left them alone. Some natural processes simply stop operating when we make it nice and neat, and it may be that those processes are worth understanding. It is to these undisturbed corners of our own backyard that I wish to call attention.

It is often stated that water tables are falling, that floods are increasing, that the soil resource is deteriorating, and that much of our irreplaceable topsoil is slipping seaward. As scientists, it behooves us to take some interest in these questions and, as scientists, to obtain the truest and most objective answers possible. But whether one approaches these problems as a citizen or as a scientist, he immediately faces the fact that answers to these questions must be stated relative to some standard base or datum. What are you going to compare against? Is the standard or datum itself a fluctuating one? Can we possibly agree on a reference point? If each person who tackles such a question uses a different reference for comparison, it is quite obvious that all the answers will be different.

Let us take the question of falling water tables. We must begin with a mutual understanding of certain hydrologic principles. During rainless periods, the flow of water in any small stream is the water which is contributed from ground-water storage. Streamflow in periods between storms represents the overflow of a full ground-water reservoir. When you fill the bathroom basin preparatory to the morning shave, water flows out the drain holes only after the basin has been filled. You know that. Such outflow ceases when the water level in the basin drops to the lip of the overflow orifice. So also in a headwater tributary; the stream will stop flowing when the water table drops to the elevation of the nearby stream bed.

When an irrigator drills a shallow well near a stream, pumping may reverse the direction of flow, which normally proceeds from the valley deposits to the stream channel. When pumping draws the water level in the valley fill to an elevation below the surface of the nearby stream, water from the stream tends to flow into the valley deposits. The shallow well actually may be yielding water which a very short time ago was flowing merrily down the river. In many semi-desert areas, on the other hand, the normal flow is ordinarily from the river laterally into the valley fill.

Under certain circumstances, one can increase the amount of ground water available by pumping the water out of the ground-water reservoir. Such pumping induces infiltration of streamflow into ground-water storage. Pumping of ground water results in a local lowering of the water table, because some local lowering is necessary to provide a water-table gradient toward the well. Thus, any use of ground water necessarily implies at least local lowering of the water table. In this sense then, the lowering of the water table is a natural and expected —in fact, a necessary—result of pumping. The question is not whether there is going to be a lowering of the water table, but rather how much lowering of the water table is permissible, how much is deleterious, and in what way?

The answer to this is neither simple nor unequivocal. In the first place, the natural daily, seasonal, and secular changes in precipitation cause responsive changes in natural recharge. These changes in the rate of replenishment to ground-water storage do not show up immediately, because first, water in the ground usually moves slowly, and second, because available volumes of storage in an aquifer may be very large.

Ground-water levels are constantly changing owing to natural conditions. Because of the slow and often damped response, changes due to natural causes usually cannot be computed with any accuracy. This being so, it is often nearly impossible to segregate clearly the changes in water level due to natural causes from those due to man's activities. Among man's activities, you well understand, we must include not only pumping, but the effects of land use, changes in ecologic associations, changes in soil properties in recharge areas, and other kinds of effects.

There are very few areas, except in the special hydrologic environment of some mountainous terrain, where one could follow ground-water changes due to natural causes alone. Nearly all environments are not only altered from their original state, but are constantly in the state of still further change. For this reason, only in areas of severe ground-water depletion, primarily in some portions of the southwestern and southern states, is it absolutely clear that ground-water withdrawal is greatly exceeding the rate of recharge. In those places, continuation of withdrawals at present rates obviously will, in time, lead to complete exhaustion of the supply or to pump lifts which are in excess of the limit of economic feasibility.

It is said by some that a large number of small reservoirs in the headwaters of a drainage basin and the maintenance of forests or grassy cover would increase ground-water recharge and would thus help to solve the problem of overdraft. The evidence for this view, interestingly enough, is mostly inferential. The ability of a good vegetative cover to maintain soil tilth, and thus infiltration capacity, is very well known. But infiltration into the soil mantle is not synonymous with infiltration to an aquifer. At each level, soil capacity for moisture, that is field capacity, must be satisfied before water can move to greater depth. Nearly all vegetation draws its moisture from this source. Since, in the hydrologic cycle, an average of three-fourths of precipitated water is returned to the atmosphere by transpiration and evaporation, it can be seen that the take of the first claimant, evapo-transpiration, is large. Thus it should not be assumed *a priori* that there will be in any individual case a net gain of water to surface streams, or to aquifer storage, by building surface-storage reservoirs. There is only one study adequate in depth and extent to give us qualitative data on such a situation in actual practice: it shows that small reservoirs or stock ponds in the Cheyenne Basin, Wyoming (average: one stock pond per square mile) caused a net decrease of streamflow by about thirty per cent.

With regard to a heavy cover of vegetation's increasing ground-water recharge, we may remind ourselves of the well-known fact that selective cutting of forests increases demonstrably water yield under at least some circumstances. The increase of water yield comes from decreasing transpiration by cutting some of the trees.

To summarize, the ecological system—man, land, pump, plow, trees, and climate—experiences much larger variations in ground-water levels than existed in the simpler system of land, trees, and climate. How much larger and how important are these variations it is difficult to assess until the situation is flagrantly out of balance. By that time, the trend is nearly irreversible and usually continues until the limit of economic feasibility is reached.

Now one connotation of the word "civilized" is awareness of the consequences of one's actions. A civilized nation could, and should in my opinion, afford the maintenance of certain control areas for the study of natural variations in physical phenomena, such as ground-water conditions. But the lack of a datum increases greatly the difficulty of making a thorough diagnosis of trends and prospects of ground-water conditions in a given area. The lack of such a datum greatly increases the difficulty of appraising the volumes of water available, and the rates of recharge, and of understanding the implication of changes of water table; further, it makes very difficult the prognosis of future status of an individual aquifer. These difficulties, I repeat, partly account for the dearth of adequate appraisals of the water situation in major aquifers in the country. There are not many aquifers where a complete quantitative appraisal is available to us, and one of the reasons is that these differences between natural and man-made fluctuations are so difficult to separate.

Let us take another, and perhaps simpler, example. We ask: are floods increasing owing to man's activities? As usual, it is necessary to begin with a mutual understanding of some of the hydrologic principles involved. A flood is a river discharge sufficiently large that it cannot be contained within the channel so that the water flows overbank. It is a characteristic feature of all natural river channels that they are constructed by the river just large enough to contain relatively small amounts of water in a relatively frequent flow. The bank-full stage of a natural river channel occurs, on the average, about once a year, regardless of the size of the river. Flows larger than this must naturally spread over the flood plains (the broad flat areas that adjoin the river channels in many areas). Thus, with reference just to the characteristics of the rivers themselves, overbank flow may be normally expected, on the average, as often as once in two years; much more often, as a matter of fact, than most people know.

Overbank flows, or floods, cause damage because man builds structures, grows crops, or otherwise uses flood plain that the river needs at times of great flow. With the increase in population and industrialization, the fertile and level flood-plain lands become more intensively used, and thus there is a tendency to increase the amount of damageable property potentially within the reach of floods. This is one of the principal reasons for the progressive increase in actual flood damage in the United States, up to the passage of the so-called Flood Control Act of 1936. Since the passage of flood-control legislation, about three and one half billion dollars have been expended on physical flood-control works. As a result, a large amount of damage has been prevented, damage which would have occurred in the absence of those flood-control works. Yet, since 1936, the actual flood damage experienced annually in the United States has not decreased, presumably owing to a rate of further encroachment on river flood plains which exceeds the building of control works.

But again, it is very difficult to determine accurately how much natural, or strictly climatic, vicissitude accounts for the flood experience on any given river. Conversely, the hydrologist cannot evaluate the extent to which flood occurrence, in contrast with flood damage, has been altered by the various direct and indirect influences of man on the environment.

In water yield, that is total river flow, separating the effects of natural from man-induced changes ought to be easier, because the seasonal and daily fluctuations can be eliminated by expressing water yield as total flow on, say, a yearly basis. By so expressing water yield, you remove the largest fluctuations. Yet even these data are difficult to interpret. Many gauging stations in the Upper Missouri River Basin, for example, show what appears to be a rather consistent trend toward lower values of total runoff in the past two or three decades. Yet some individual stations in the same area do not show the trend, and over the United States as a whole, there is no distinctive and consistent trend in the records.

Now since we know that long-term temperature records, glacier recession, and certain oceanographic and meteorologic elements indicate a general warming, at least in the northern hemisphere, we might expect an accompanying trend toward aridity and consequent decreasing runoff from these natural causes. But, because there is no adequate control which shows such trends uncomplicated by man's activities, clear-cut conclusions cannot actually be reached. There is reason to suspect, now, that even our long records of precipitation and temperature have been affected by influences of man on the environment.

When the total period of record, of streamflow and other hydrologic elements, becomes much longer—let us say twice as long as the presently available sixty-odd years—statistical variance will be better defined. But by that time man's effects and his pressures on the environment will be even more extensive and pronounced. It may well never be hydrologically or statistically possible to demonstrate what part of the experienced variations in hydrologic conditions is natural and what part is caused by man.

Is it important that we know? Well, there is certainly much confusion, in several fields of activity, resulting from the fact that such questions cannot be clearly answered. For example, graziers maintain that livestock has little to do with the widespread gullying of Western valleys, while many others maintain that grazing is the principal cause.

Because no unused, or nearly unused, area exists which is in all principal respects similar to the region under discussion, the factors must be analyzed by roundabout means. Even now, after years of study by many qualified specialists, there is still much we desire to know.

It is clearly shown by geologists that alluvial valleys were channeled by gullies several previous times, in late Pleistocene and geologically recent times, before there could have been any important effect by man. These gullies eroded the floors of alluvial valleys in response, it is believed, to changes in rainfall-runoff conditions associated with climatic variations, but the magnitude of climatic change required to cause what was observed is essentially unknown.

It seems equally clear that the epicycle of erosion which began in the southwestern states in the nineteenth century must have resulted from a combination of climatic and man-made effects, such as grazing. The relative importance of each is still quite unclear. Partly for this reason, it is not possible to forecast with any certainty what will be the future of the arroyos which we now see in the valleys of the West. My own studies of this question lead me to believe that the gullies in Western valleys will not aggrade by deposition in the next several generations but will gradually tend to stabilize with rounded banks, which will eventually be covered with vegetation. I for one would be intensely interested in seeing some area typifying the alluvial valley-gully problem protected indefinitely from further use, by man or by grazing animals, and in observing what will happen from this point on in the erosion-sedimentation history. It would be known, of course, that such an area had already been exposed to much in the way of man-made changes, but it would be protected indefinitely from further use.

For long-term observation of the effect of climatic changes on runoff, the United States Geological Survey is anxious to establish and maintain what we would call "bench mark" gauging stations, measuring streamflow from areas which are as free as possible from future man-induced changes. Of the 7,000 gauging stations now maintained in the United States, less than a handful seem to fit the requirement. Even for those, there is no guarantee that the drainage basins will remain free of man's influence indefinitely.

The vast national programs of hydrologic measurement are motivated by the same things that alter the landscape: water storage, flood control, river regulation, and things like that. But virtually none of these programs is devoted to finding out what changes in the natural regimen these works are going to effect. Much goes into an evaluation of a benefit-cost ratio, but no effort goes into an evaluation of man as an agent of ecologic, and even of geologic, change.

The most powerful tools of statistical inference cannot do what a bench mark station can do—unravel man from nature in the records.

Many branches of science would benefit from the study of representative areas maintained, as nearly as possible, in their original condition. The examples I have given would not actually be set up for the purpose of study; they would simply be set up for the purpose of comparison. Detailed research on those areas need not necessarily be done to answer some of the questions posed by these examples—but much research could be done on such areas. Not only the hydrologist and botanist but many other specialists might find knowledge there of great practical and intellectual interest. The Belgians, interestingly enough, have already recognized this need, and the administrative direction of the great National Parks in Africa is specifically oriented with this in mind. One of the fathers of the Belgian Park System in Africa, M. Van Straten, told me that in one of these untouched areas scientists found a spot where the bacillus causing tetanus does not occur. Tetanus is an organism so ubiquitous that to discover a place where it does not exist is indeed a rarity and good luck. Study of its natural enemies there might eventually provide a hint as to how the disease might be controlled. But here I am thinking in intellectual rather than economic terms.

In the field of hydrology, many natural processes can be studied in very small areas. Nevertheless, even the preservation of small basins typical of some of the important ecologic and lithologic types could be of significant value for hydrologic research purposes.

Science is shooting for the moon. Personally, I would be content with much less. If we have learned enough to reach the moon, one would hope that we had learned enough to apply some of this great scientific energy to a few small areas in our own backyard. But we undoubtedly will reach the moon, and start to alter its hydrologic environment before we have set aside some representative land museums for hydrologic study here.

The Spartans left us a little sample through inadvertence. Though that sample leaves much to be desired, it is still better than nothing. Presumably, we should not have to rely on inadvertence to leave something similar in America, and it is not yet too late to begin.

DISCUSSION

Richard M. Leonard, *Discussion Leader*

Leonard: I think you can all see that we have had a fascinating account of the real need for further reference points, bench marks, or data that you can relate the changing world back to. If we don't get reference points we are unable to really understand some of these long-range problems that are involved in water—and without water, as we all know, the human race and most other forms of life would disappear.

Paul Zinke (School of Forestry, University of California): I would like to ask Dr. Leopold if the U.S.G.S. currently has a program of maintaining bench mark stations evaluating watershed yield from wilderness areas, or if they have any plans for such a program.

Leopold: Thanks for asking that question, because I did not make myself clear. We would like to start out by picking stations now in existence which we think might satisfy this requirement. We, like most other scientific agencies, are pressed by: "How are you going to spend your money?" We are certainly going to install a few new ones in the next few years. I would not say that they necessarily would be in or adjacent to wilderness areas, but presumably some of them will be maintained by simply naming the ones that are now running. There will be some new ones, but there will not be very many—not because of money, but because it is hard to find the kind of area you want to measure, one whose hydrologic environment really represents what you wish to use as a long-term bench mark or datum. The point is, you see, that once you choose one you have made a definite commitment to the future, so that it is an administrative and technical problem of considerable significance that once you so designate one you are going to be stuck with it, and you had better make your choice well, so that someone two generations hence would have to agree with you that you had made a good choice.

Leonard: That is a very important point—the continuity of studies relating to the natural climatic conditions. I think one of the great tragedies is the abandonment of the Soda Springs snow depth recording station, here in California, after seventy-eight years—the longest recorded history in North America—in March of last year. I don't know whether it has been revived again or not, but there is a record of seventy-eight years built up that was at least temporarily abandoned.

Zinke: I would like to address one more question to Dr. Leopold. In this regard, Tenaya Creek has been used as a check watershed by the Division of Watershed Management of the U.S. Forest Service because there was a good record of the past. Recently, the U.S.G.S. curtailed the taking of records on this creek. Is there any reason for this that you may have in mind or know of personally?

Leopold: No, not in regard to any individual station. I would rather not comment because I would not necessarily know the exact circumstances. I would like to say, however, that any hydrologic network, to give you the largest amount of information per dollar expended, should consist of a series of base stations quite different from bench marks, but relatively long-term stations which are going to be used for correlation with short records on a variety of other streams. In such a way, you would have what might be called roving or satellite stations to be run only long enough to establish a statistical correlation with the longer-range stations. I would like to add, too, a third category of the so-called bench mark stations, those to which you have an indefinite commitment in the future.

Mrs. Neil Haig (Seattle, Washington): What value has the miniature dam on the farm to the water table in the area?

Leopold: That is a very good question and very difficult to answer; we don't know. Many people, because they would like to have something they can come to grips with, say: "Well, this is a good thing." It may be a good thing and it may not be a good thing at all. It is not clear that in general the small upstream dam will help the local water table, because it turns out that you are first exposing an area to evaporation. Secondly, the seepage and the sustained runoff that comes through the discharge pipe, whether gated or ungated, is going to maintain a better vegetation immediately below the dam, and so you have increased your evapo-transpiration losses. Then you wonder—even within the small area of the farm itself—did they gain or did they lose water? You may build a dam for stock purposes, or for swimming, or for recreation and be perfectly justified from that standpoint. But let us not say that it is necessarily good for everything, because for every gain you get you are likely to be sustaining some losses. This is a problem which in many cases we actually can't solve.

Leonard: You see that this is an extremely complex problem and points up the need for more and more study and data.

William Yeomans (California Public Outdoor Recreation Plan Committee): I would be very interested if Dr. Leopold could point out any instances of natural environment parks where there is observed any effect from overgrazing of elk or deer—the natural fauna—which is not necessarily the product of man's entrance into the picture.

Leopold: That again is a very good question. Let me try to answer it this way. On small experimental watersheds one can show clearly the effect of differing land uses by comparing an unused control with a watershed which is altered. This use could be for grazing, lumbering, or different tillage methods. But if you have a sample of let's say 1/100th of an acre, or three acres, or even ten acres where this could be clearly demonstrated, how do you relate that to something of ten square miles or 150 square miles or 1,000 square miles? You immediately bump into the strictly hydrologic problem that you cannot apply unadjusted the results from a small watershed to a large one, because for many hydrologic reasons—channel storage, soil moisture, soil differences, vegetative differences, and many other things—it becomes complicated. There is a tendency for people to think: "We have proven it on the little plot, and therefore it must be true on the large watershed." This is the problem: it is not necessarily true, and so again one of the things that we are missing in hydrologic investigation is samples of large enough size with such control. We have many areas that are used extensively, but there is no control against them. After you get to 500 square miles, who has a 500-square-mile watershed that he would like to dedicate to no use at all, so that we could compare it with the used watershed adjacent to it? We are bumping again into the same problem: no bench mark when you get into the large areas which you have not previously investigated.

Norman Livermore, Jr. (Pacific Lumber Company, San Francisco): I believe you said that selective cutting of forests increases water yield sometimes. I wonder if you can elaborate on that a bit. How selective was the logging, and how much did the stream flow increase?

Leopold: The literature was quite clear on that: it was done in several places. I think the most well known are the forest station at Coweeta and the Fraser experimental area in Colorado. There is investigation in the Wasatch, and I think the Forest Service publications on this matter are pretty self-explanatory. The idea, as you can imagine, is that by selective cutting, usually in the form of thinning, the total of rapid evaporation was decreased which allowed a certain proportion of that to increase the stream flow from the area.

Zack Stewart (Spencer, New York): I wonder if you would like to comment on the reapportionment of vast volumes of water as proposed by the California Water Plan. What effect will that have on California's ecology and perhaps the hydrologic cycle as operated here?

Leopold: Well, that really is a question. As a matter of fact, it is a question that would be very difficult to comment on briefly, partly because it is a large question and partly because I am certainly not an expert on local California conditions. I think, however, that in trying to make an evaluation of any set of project proposals, many of the hydrologic problems that I was just speaking of will face any state or any area.

Leonard: That is always one of the complicating problems which point up the need for a control area. As you move large bodies of water from say the west side of the Rockies over to the east side (as many projects plan, and as some are actually accomplishing in the Colorado Big Thompson, etc.) then you do change a lot of situations.

Hans Jenny (Department of Soils, University of California): I was especially interested in a comment you made to the point that we have records or evidence that we have a man-induced climatic change. I assume you mean a climatic change on a regional basis. Would you be kind enough to elaborate on this point?

Leopold: Yes, I am glad you gave me an opportunity to say something about this. It consists of two parts. We are not at all sure whether the change in carbon dioxide content of the atmosphere, presumably man-induced, has actually been at least partially responsible for the observed trends in the past several decades. The other thing I was referring to is of a somewhat different nature. We know now from investigations primarily in Scandinavia and some other places, that important changes in temperature occur in the vicinity of cities where the investigations have been made. Inasmuch as the longest temperature records, for example Hartford's in the United States, are temperature records associated with cities, then you have the possibility that the temperature records are biased in that they represent a local temperature change. There are no measures of the temperature changes in the whole hemisphere.

JENNY: Thank you, but these aspects are important too in many areas. For example, the Indians claim that the deserts are on the march, and in fact it is true that the neighboring desert is moving in the direction of New Delhi so many miles a year. The Indian people think the regional climate has changed as a result of deforestation. Ecologists, however, claim that land use has changed. The vegetation was cut down, and so the sand bodies started marching by the wind. Now what sort of evidence could we have to really investigate for sure that the climate regionally has changed aside from city observation stations?

LEOPOLD: I imagine that the best evidence we have is stratigraphic. I am thinking of post-Pleistocene changes, such as the epicycle of erosion that occurred during the drought of 1200 to 1400 A.D. in the Southwest. These are the only kind of records really available to us. One of the things that we are doing in the Geological Survey's glaciological program is making the glaciological program a hydrologic tool for trying to discover not merely the mechanics of the glacier itself, but what kinds of climatic elements are affecting the glacier. So there should be, presumably there will be, developed a better indication than we now have of how to use different natural phenomena of glaciers, stratigraphic history, together with pollen-dendrochronology to help extend even the relatively long records that exist in places like Europe.

But now speaking about the situation in India, you indicated that the Indians feel deforestation has actually been one of the causes of change in climate which they believe occurred. But the Indians also have the feeling, for example, that small basins and reforestations in the foothills of the Himalayas would be a solution to their problem. I think actually that there has not been as much work done in India on geological and stratigraphic evidence as has been done here. I suspect that they are going to come essentially to the same conclusion that we have: you are dealing with a combination in each local situation, of climatic and man-made effects, and we so far have not been able to completely unravel it.

HOWARD ZAHNISER (Executive Secretary of The Wilderness Society, Washington, D.C.): There is now pending in Washington a bill that would declare it to be the policy of Congress to secure the dedication of an adequate system of areas of wilderness to serve the recreational, scenic, scientific, educational, conservation, and historical needs of the people. The areas that would be affected by that legislation are in National Parks, National Forest areas of wilderness, Refuges, and some others. Would you comment on the opportunity of serving these scientific needs you have spoken of so graphically in areas that would be established for this multiplicity of purposes? If you would call this a multiple-use wilderness bill, is it feasible to anticipate that the areas so established for all these purposes could also serve the scientific needs you were talking about?

LEOPOLD: Yes, that is one of the reasons I am here. But I am more or less of the same opinion that Dr. Cain expressed this morning: we haven't got a very good point in arguing that research is going on in such areas, when the fact is that a very small amount of research is now proceeding. With regard to the future, this is not a very strong argument, but now you are asking me from the standpoint of science. Certainly some of the kinds of area I am speaking of could and should be in the areas that would be protected by the Wilderness Bill, but I would like to add to that, that with regard to the kinds of hydrologic problems that I was speaking of the need is even greater. So I am suggesting that over and above the need for a mountain wilderness there is still a need which I think was mentioned, if only by implication, by both speakers this morning; it is more than high mountain areas that we must consider if we are talking about the whole use of science and lands.

ZAHNISER: May I ask two other questions related to this? First, do you think the recreational uses we are familiar with in these areas would necessarily interfere with the establishment of these bench mark stations and other installations for scientific purposes?

LEOPOLD: Yes, that is a good point and one well worth giving consideration to. For many hydrologic purposes it would be my off-hand opinion that such recreational use (I am speaking now of trail use, not organized camping areas) would not at all hurt the hydrologic environment, but obviously there are some other kinds of studies where even that kind of use would be somewhat detrimental. But I do think that for hydrologic research, one could make the statement that we could get along quite well with the modest amount of use that one would be subjected to in areas that might be chosen. That is, the complete elimination of use would not be necessary for many hydrologic purposes.

ZAHNISER: And finally, that being the case, you are a little more optimistic than I thought you would be about the compatibility between the two. It seems to me that they have been discussed as compatible, but would it not be a good function for the Council proposed in the legislation (when it is established) to give some distinctive attention to the use of these areas for scientific purposes, and shouldn't there start at this conference some definite thinking along those lines? That is almost a rhetorical question as it sounds, but I don't mean it that way. We have been talking for a decade at these conferences of these values, but as it was implied this morning, the actual instigation of some thoughtful program for seeing that these areas are so used is a challenge we haven't met. It seems to me you have stimulated it very much.

LEOPOLD: The kinds of problem we have in hydrology, though, were very neatly brought out in the questions this morning. Are these lands to be managed? Are you going to try to use controlled burning, for example? What do we mean by management? What should be the objective? How bad is the risk? If you had a dedicated area that you were using for bench mark stations, how bad would be the risk of complete fire protection? How difficult would be the influence of management let's say by controlled fire to try to maintain the environment over a long period of time? Those, I believe, are the questions we will be faced with. How is the land to be managed? Would you be satisfied with land that was completely protected? That in a way is a form of management.

LEONARD: That about sums up our problem. We do have to make that long-range basic choice: what are we after? Are we after a status quo? Are we after an evolving evolution? These are the problems to think about.

DAVID BROWER (by footnote to a brief report on Dr. Leopold's paper in the *Sierra Club Bulletin* and by subsequent letter inviting further discussion): *The discussion of your paper spoke of increasing water yield through selective cutting. Water yield would increase still more if* all *the trees were cut and all other water-transpiring vegetation were stripped off. The yield of silt and sediment would also increase—astronomically. Data on the long-range effects of watershed manipulation are too scant to permit adequate appraisal of the results. Unmanipulated watersheds—wilderness—will be essential for purposes of comparison when such appraisal is sought.*

On a recent flight to the Northwest I saw, as I have often seen, the difference between logged and untouched watersheds, as marked by the color of the streams below them. I have been watching the bulletins on the various watershed-management projects fairly regularly, but nowhere have I seen enough evidence of concern for the total land mechanism. You yourself could make a great contribution on this, considering your position with the

Geological Survey and your detailed knowledge of your father's philosophy as seen in *Sand County Almanac* and *Round River.*

How can a complementary survey of forest practices be initiated on the general topic, Where does the silt come from? It seems to me that such a survey needs to do this:

From the air.—After a good storm, find out which forest-area streams are clear, which muddy, and where the mud comes from. Photograph successive junctions, using color photography where appropriate. Make obliques and verticals in stereo strips of the watershed of mud-carrying streams and clear streams.

On the ground.—Photograph the same areas, with close-ups. Compare virgin forest with disrupted forest. Study the biota and the soils in their roles as protectors of watershed and water quality.

Subsequently.—Put together a type map and study the correlations. Find out who owns the damaged watershed, whether it was logged, and under what supervision. Develop a yardstick for measuring the cumulative loss over a century, in economic and social terms, to demonstrate the *un*sustained yield if that is what is occurring. Relate the benefit-cost analysis to the gradient of the slopes disrupted. Analyze the curriculum of the personnel who made the decisions that produced the muddy waters.

All of us realize that there must be logging, and if it can be done so as to produce a better water yield, fine. If, however, timber harvesters are subconsciously looking for a way to rationalize the building of timber-access roads into steep terrain they shouldn't enter, then that is another matter.

Some further apprehensions, stated briefly, are these:

The Coweeta experiments.—In North Carolina the Forest Service found they could increase water yield by cutting down everything and letting it lie there. Regeneration was also cut and left. Transpiration was reduced and more water flowed out of the watershed. But so far as I can see, they did not measure what was happening to the centuries-old accumulation of soil, and the vital reservoir it has become through natural processes, when they interrupt the growing process on top that makes that reservoir. For example, if a profile of the top twelve inches shows organic material dating back a century or more, then it seems important that there should be experiments under way to determine what becomes of this old organic wealth—and the "dark lakes" beneath it—if you maim it and speed the water downstream. The experiment should be over a long period.

The San Dimas experiments.—In California the Forest Service found they could get more water if they grew grass instead of trees on the watershed. The grass roots go down three feet, the tree roots eleven. But what happens if you permanently interrupt, in that lower eight-foot zone, the simultaneous anchoring and fracturing accomplished by tree roots? Are we interfering with an important process of soil building or are we opening the way for sheet erosion that will strip the land down to rock, producing the kind of scenes we shrink from in the Middle East? Do we not need deeper research planned to evaluate this hazard?

For controversies that have not erupted yet we need what you helped produce in the flood-control controversy—a good technical review by skilled people independent of the governmental agencies affected. Perhaps it is not fair to look to foresters for answers about the soil mechanism when they are under such great pressure to increase the allowable annual cut of the timber resource.

Dr. Leopold (replying to some of these questions by letter of April 12, 1960):

Owing to the fact that vegetation transpires water, total water yield under certain circumstances can be increased by eliminating part of the vegetation. It could be argued that a large part of the water transpired from a vegetative area would appear as stream flow if all of the vegetation were eliminated. Under those circumstances the runoff could be expected to be extremely high in sediment relative to the vegetated conditions, and the elimination of vegetation from the watershed would subject the basin to serious erosion by gullies and rills.

Clear cutting of a vegetated watershed for the purpose of increasing water yield to the maximum will, in practice, not necessarily yield the largest amount of water, regardless of the quality of the water so produced. The elimination of a large proportion of the native vegetative cover will increase the flashiness of runoff. Both the soil and channel under those circumstances would tend to dry out in rainless periods, so that when runoff occurred relatively large amounts of water would be lost as infiltration of the channel and to the stream banks, from which it would be evaporated or transpired. Channel losses then may be expected to materially increase in a flashy stream as compared with one having sustained flow.

For this reason, by no means all of the water which is saved from transpiration by the native vegetation will actually be available downstream for capture and beneficial use. Furthermore, channels will tend to be unstable under these conditions and subject to aggradation or degradation, increasing the difficulty of managing both sediment and water.

As a consequence it is completely unrealistic to imagine that the maximum water yield will be achieved by the elimination of all or most of the native vegetation on a watershed. The esthetic losses would of course be manifold.

An alternative solution would be offered by selective cutting in a forested area for the purpose of increasing stream flow. Experiments have shown that tree thinning under certain circumstances will result in modest increases of water yield.

It can be expected, however, that erosion losses from the basin, and therefore sediment movement in the channels, will probably increase faster by far than will the water yield. It has been shown by many types of experiments and field observations that a given change in vegetative density results in a geometric increase in sediment movement relative to the effect on total water yield.

In actual practice, therefore, the costs or losses due to the increased sediment yield and the degradation of the esthetic value of a watershed may overbalance the benefits due to increases in water yield beyond even modest amounts of selective cutting of the vegetative cover.

In semiarid areas there is the possibility of increasing water yield somewhat by a change of vegetative type from, let us say, woodland to grass. The conditions under which this change would actually result in an increase of water yield downstream are at present problematical. Presumably such an approach would be more effective in deep soils than in shallow, because in deep soils tree vegetation can be presumed to be depleting a thicker soil zone of moisture by transpiration than would a grass cover.

On the other hand, it has been shown that many grasses can develop deep and highly ramified root systems where the soil materials are thick. Furthermore, many different vegetative types have experienced a serious encroachment of brush in the past half century, presumably as a result of the decrease of fires, the increase of grazing, and possibly also as a result of climatic variations. This experience suggests that it may be quite impossible to maintain a grass association indefinitely on an area which under natural conditions has been supporting woodland.

The ecological succession in other words may preclude a permanent conversion from woodland to grass under certain circumstances. Certainly at the present time too little is known about these general relations to justify large-scale operations aimed at increasing water yield by changes in vegetation. So varied are the possible adverse effects, and so limited the demonstrations of water-yield increases resulting from substitution of vegetation, that it would be extremely hazardous to begin such operations on a large scale until the limited research now under way, and much broader research programs, have been prosecuted and brought to completion.

Sincerely yours,

Luna B. Leopold

ROBERT RAUSCH

The Outlook for Conservation in Alaska

Robert Rausch received the degree of Doctor of Veterinary Medicine from Ohio State University, and his Ph.D. in parasitology from the University of Wisconsin. He has also studied at Michigan State University. He is now associated with the Arctic Health Research Center, United States Department of Health, Education and Welfare, and is chief of the Zoonotic Disease Section.

The destruction of irreplaceable Alaskan wilderness by special-interest groups is a fearsome possibility. Time remains for preservation of the astonishingly small amount of truly wild land remaining, but time passes rapidly. National Monuments are most vulnerable to exploitation, while their potential value as recreational areas is indicated by vastly increasing utilization of Mount McKinley National Park. Dr. Rausch proposes the establishment of state parks. He wisely adds that public education as to the value of conserving natural resources, while needed everywhere, would be especially appropriate now in Alaska. His paper provides a most informative survey of existing wilderness preserves and those currently proposed.

CONSERVATION in the broadest sense includes not only wise economic use of resources but also the perpetuation of natural areas with all their components, areas which may be utilized repeatedly by man and still left undepleted. The utilization of natural areas for scientific purposes is one of the most fruitful, as well as the least harmful, of the kinds of repeated use. In the past, Alaska has provided opportunities for basic research in many disciplines, largely because most of its area was in a primitive condition.

It is difficult to predict the effect of statehood on Alaskan resources, but it appears that it can do little more than accelerate the changes already in progress. Alaska is subject to the same pressures being felt in other parts of the world, not the least of which is a rapidly growing population. There is an ever-increasing demand for unrestricted development of the natural resources in order to promote further population growth and an industrial economy.

Although the development of Alaska is progressing at a comparatively slow rate, it is already evident that exploitation of some of the natural resources has been excessive and without much regard for the concept of sustained high yield.

One of the best examples of this is the seriously depleted salmon runs; another is the rapid disappearance, during the last decade, of undisturbed wilderness areas. I should like to review briefly some of the factors, such as fires, agriculture, development of mineral resources, and others which are bringing about these changes.

One of the most important causes for major vegetational alterations is fire, and to some extent it must be regarded as a natural phenomenon although in recent years many fires have been accidentally caused by man. The occurrence of fires and their ecological effects in Alaska have been reviewed by H. J. Lutz, in a publication of the U.S. Forest Service. Annual losses are very great; detailed statistics have been published by Lutz, and it suffices to say that the average area burned annually during a 15-year period beginning in 1940 was about one and a tenth million acres. Much damage can be expected in the future, since outbreaks are not often detected soon enough to permit rapid control.

Although there is great popular demand for settlement of new lands in Alaska, the agricultural potential appears to be much more restricted than was formerly believed. Hugh Johnson, agricultural economist with the U. S. Department of Agriculture, in a critical survey published in the 1958 *Yearbook of Agriculture,* states that a maximum of two to three million acres is physically suitable for cultivation, and as much as eight million additional acres could be used as pasture or rangeland. The maximum total area comprises about 17,200 square miles, or three per cent of the area of the State. In 1957, there were 20,000 acres of cropland in Alaska, while idle cropland and acres on which crops had failed made up an additional 2,000 acres.

With a sixty per cent increase since 1949, the present population of Alaska is about 211,000. According to the most conservative predictions made thus far, a population increase of about one hundred per cent is to be expected during the next decade. Irrespective of the validity of the estimate, most of the increase will undoubtedly be seen in the subarctic regions of southern and south-central Alaska, where conditions are most favorable for agricultural and industrial expansion.

New homesteads are continually being established, but relatively few have yet become productive. Johnson, in 1955, made an investigation of agricultural settlement on the Kenai Peninsula. Homesteading had been going on there for a period of forty years, but he found that fifty-nine per cent of all entered or patented land on the Peninsula was unoccupied and abandoned as of July, 1955. Another thirty-one per cent was used only as places of residence for persons not engaged in farming. Only one and three-tenths per cent of the occupied land was cropland, and nearly half of this had been cleared since 1950. Only fourteen per cent of all the income reported by homesteaders in 1955 came from the sales of farm products. In the Homer community alone, sixty per cent of all entries from 1915 to 1945 had been canceled, relinquished, or closed by decision. The situation is similar in the Tanana and Matanuska Valleys.

The high cost of clearing land, the long period of time before realization of any income, and insufficient demand for the most easily produced crops all contribute to the failure of homesteads. Few people today are willing to live as subsistence farmers, but it appears that little more can be expected during the first years of homesteading. In a paper presented at the Ninth Alaskan Science Conference, in 1958, Johnson pointed out that Alaska is not destined to be a major agricultural region, and that sufficient good land is either patented or available to meet the potential demand for farm products for years to come.

Fishing is still the most important industry in Alaska. The total value of fisheries products was about seventy-eight million dollars in 1954, and seventy million in 1955. Efforts are being made toward broader utilization of the fisheries' resources, and the outlook is generally good. Crabs, shrimps and other groups are all increasing in importance.

There has been a constant decline in the numbers of salmon, and the future of the salmon fishery depends upon successful rehabilitation of this resource. The highly efficient salmon traps have finally been abolished, according to the latest available information; this action ostensibly has great conservation value, but this probably won't be the case in practice, for the present attitude is to substitute other methods for the traps so that the total take, unless somehow regulated, will be about the same. There is much popular resistance in Alaska to the establishment of control measures designed to restore the salmon in order to ensure a sustained high yield. This is perhaps understandable, since in some areas the economic losses would be nearly disastrous, at least temporarily. Just before I left, the word came that the Bristol Bay area has just been closed to commercial fishing, but it is not at all certain that will not be changed.

Lately, there has been less tendency to blame predators for the results of overfishing, although I think it is still the practice to try to control seals in southeast Alaska by means of dynamite, and it has been learned that many "Alaskan" salmon are being taken by Japanese fishermen on the high seas. Few people but the biologists seem willing to admit that there are at present too many fishermen and too few fish.

Alaska's potential for hydroelectric power is considerable, and it is generally believed that industry would be attracted if cheap power were available. However, the resultant dams for hydroelectric purposes would also destroy some valuable salmon runs. As an example of this conflict of values, a dam at Wood Canyon, on the Copper River, would produce more than a million kilowatts. At the same time, the Copper River is one of the important salmon streams. During the 10-year period from 1940 to 1949, the annual value of the salmon pack from the combined Copper River and Bering River drainages averaged more than one and a third million dollars. Elsewhere, such as in the Kenai Lake area, a series of small dams is now being built. Each of these causes a negligible loss, but the total attrition of all these dams to the fish resources is quite important. However, each dam has been justified by the evaluation of its separate effect, which produces an erroneous concept of the effects of all, and this in the end will be the significant factor.

Construction of hydroelectric facilities in Alaska in the near future seems unlikely. The Harvey Aluminum Company, which had been granted a permit to investigate the power potential of the Copper River, has relinquished all claims. Considerable publicity has been given the possibility of establishing a hydroelectric development at Rampart, on the Yukon River, but positive action seems far in the future. Since other sources of power may be practicable within a few years, it is hoped that hydroelectric projects in Alaska will not be necessary. Large quantities of coal are now available locally but are not being used to any great extent.

Lumbering has already superseded mining as the second most important resource industry, although operations have been reduced by adverse market conditions. The utilization of forest resources is limited mainly to the coastal regions of southern and southeastern Alaska, where the Forest Service has awarded contracts for pulp and plywood operation. Only a small portion of the allotted timber is being used at the present time. When the resources of southeastern Alaska have been fully committed, it is possible that the forests of interior Alaska may be drawn upon as a source of pulp. At the present time, several small sawmills in the interior are producing lumber for local consumption, but large-scale operations are not expected in the foreseeable future.

With the exception of oil explorations, mining activity is decreasing, mainly because of unfavorable markets. Some of the larger oil companies have been investing heavily in exploration and prospecting programs in several areas. The greatest activity has taken place on the Kenai Peninsula, where three wells have been completed and two are in progress. One of these wells produced a maximum of 800 barrels per day. After having drilled a well 14,000 feet deep at a cost of about $500 per foot, one of the companies has discontinued operations on the upper Alaskan Peninsula. So far, oil operations do not seem to conflict seriously with conservation interests; the companies have been cooperative and have impounded any oil that might contaminate streams or lakes.

In January, Senator Bartlett introduced a bill providing for the abolishment of Naval Petroleum Reserve No. 4 (which lies across the Arctic Slope in northern Alaska) and granting jurisdiction over the area to the Secretary of the Interior, with the plan that resources here could be privately developed. The bill was referred to the Committee on Armed Services. In this case, opening this reserve could lead to serious damage to an important natural area.

Defense activities have been one of the most important factors responsible for changes in many areas that formerly were relatively undisturbed. The construction of the Distant Early Warning system along the Arctic Coast has left no distance greater than 50 miles without some type of installation. Sites for other purposes have been established throughout the State, usually in hitherto remote and practically undisturbed areas. These activities have led also to the building of numerous landing fields which allow access to the surrounding country.

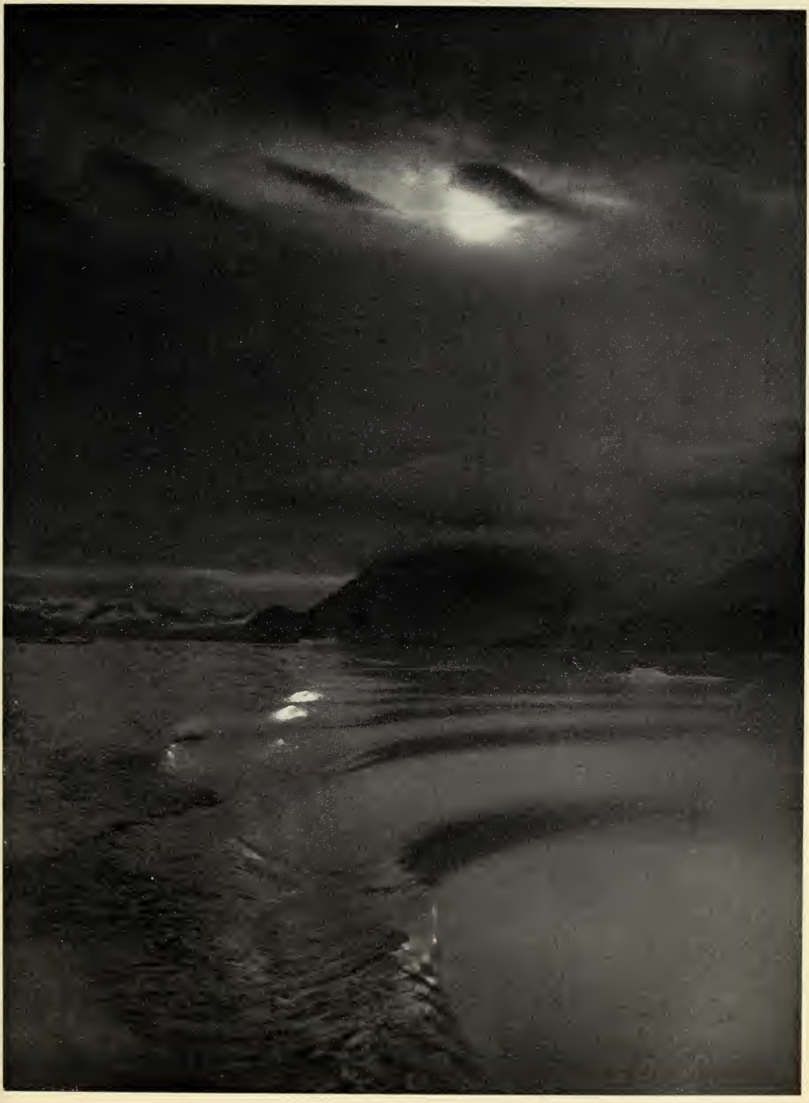
As the population of Alaska has increased, the demands for outdoor recreation have increased correspondingly. Many people who emigrate to Alaska are motivated in part by an interest in hunting and fishing; others develop these interests in the absence of opportunities for recreation of other types. A high proportion of military personnel participate in outdoor activities.

As a result of the population growth, areas readily accessible by roads from the major population centers are becoming inadequate both in quantity and quality to meet the demands for outdoor recreation. On the Kenai Peninsula, for example, lakes and streams once noted for excellent fishing have been overfished, with the result that there is much competition for space in the best remaining areas. Lakes that were seldom visited five years ago are now surrounded by cabins and their surfaces swarm with motorboats. During the big-game season, areas such as the Matanuska Valley and the country along the Denali Highway are so crowded as to make hunting unpleasant as well as somewhat unsafe.

The popular demand for better recreational opportunities has been one of the main causes for greatly increased use of small airplanes. There are at the present time about 1400 privately owned airplanes in Alaska, and as of December 31, 1957, there were 2,417 active pilots. As of April 1, 1958, there were 161 public airports. It is estimated that ten per cent of all float-equipped planes registered in the United States are based at Lake Hood, just outside Anchorage. Many of the small airplanes operate commercially to transport hunters and fishermen to otherwise inaccessible areas. Such services were formerly provided mainly by a few professional guides with long experience and good reputation, but others are participating more and more in these activities. Many of the latter operate only during the big-game season, when the demand for such transportation is greatest.

The small airplane is probably the greatest single factor contributing to the changes taking place in the Alaskan wilderness. No area containing a lake or gravel bar large enough to permit a landing is overlooked, and no region is too distant. Some more hardy individuals even hike in to regions where game is abundant in order to clear a place large enough to permit the landing of a small plane. The increased use of small airplanes has led to an active competition among the guides and certainly has greatly intensified the hunting pressure on those species of animals least able to withstand it.

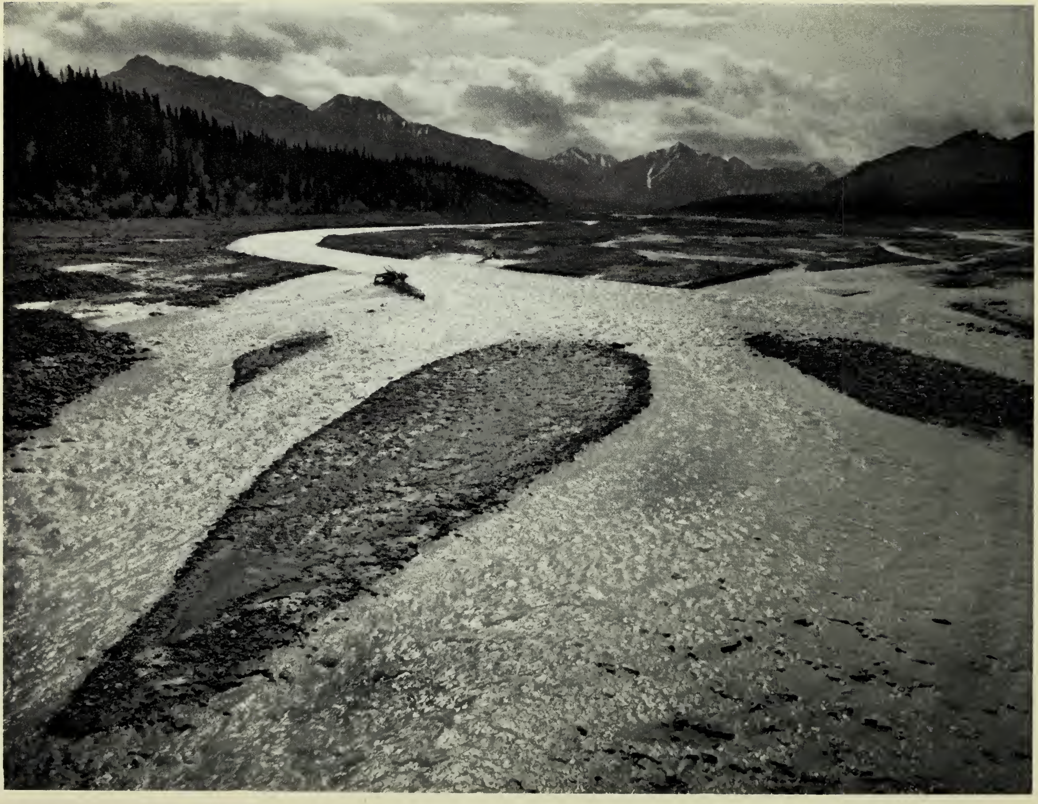
Roads are still few in Alaska, but the Seward, Taylor, and Denali Highways have, within the last years, opened great areas of previously uninterrupted wilderness. Among projects for the future, roads from Anchorage to McGrath and from Fairbanks to Nome have been given priority. It is generally true that people do not walk far from the highways, even during the hunting seasons. However, various kinds of tracked vehicles from roadside headquarters



Evening Storm, Glacier Bay National Monument

Alaska, "The Great Land"

EIGHT PHOTOGRAPHS BY ANSEL ADAMS



View upstream on the Teklanika River, Alaska Range, Mount McKinley National Park.

Grass, Bartlett Cove, Glacier Bay National Monument.

South Sandy Cove, Mount Fairweather in distance, Glacier Bay National Monument.

Rock veins, Glacier Bay National Monument.

Forest, Glacier Bay National Monument.

Ancient stump, Interglacial Forest, Glacier Bay National Monument.

Mount McKinley, near sunset, from the road to Wonder Lake, Mount McKinley National Park.

NORTHEAST ARCTIC

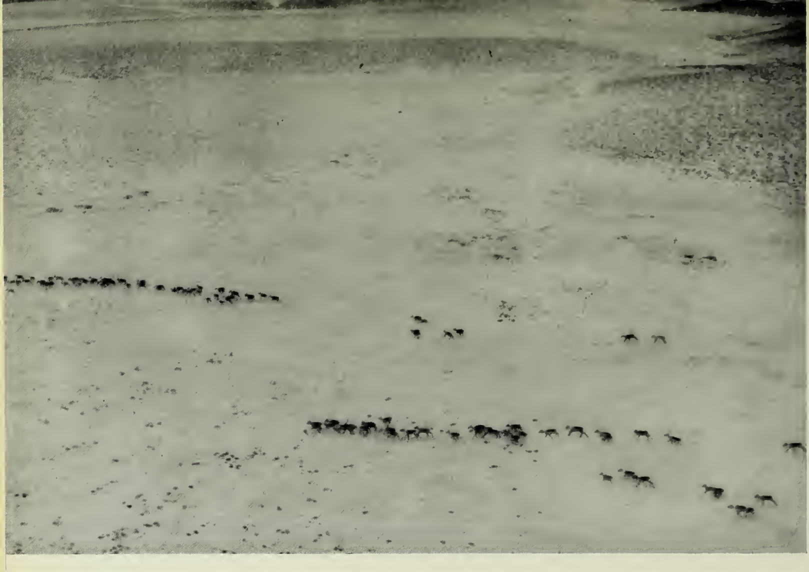
The Last Great Wilderness

The setting aside of a part of the original Arctic wilderness would be one additional long and significant step toward further understanding and use of the Northland's biological wealth; it would preserve one of the most valuable continental wildlife breeding areas—one of the great scenic and historic regions of North America

PHOTOGRAPHS BY LOWELL SUMNER

Only on the Firth River do special climatic conditions permit forest trees to extend to the Arctic coast. . . . The remote and little known Brooks Range resembles the Rocky Mountains in majesty and scale.

The adjacent lake wilderness of Old Crow is considered one of the great game regions of the continent. . . . The broad Firth River Valley, here shown at the junction of Mancha Creek (foreground) is a highway for game today, and probably once served for man.



The largest caribou bands remaining in Alaska inhabit the vast Arctic plains. . . . Like the buffalo of 100 years ago, the great caribou bands have made "roads" through the country.

Rivers on the south side of the Brooks Range afford typical moose habitat of the Yukon drainage and here the animals have not been disturbed. . . . Over hundreds of square miles the open slopes are interlaced with game trails.

This native village of Old Crow, like the historic trading post of Fort Yukon, constitutes one of the gateways to the Arctic wilderness area. . . . A typical Arctic river winding to the polar sea.

Cave area on the Firth. The geographic location, gentle topography, and unusually mild climatic conditions lead to the belief that the archeological potentialities of the area are exceptionally rich and significant. . . . Within this region are hundreds of lakes where moose, bears, wolverines, waterfowl, and fish live undisturbed.

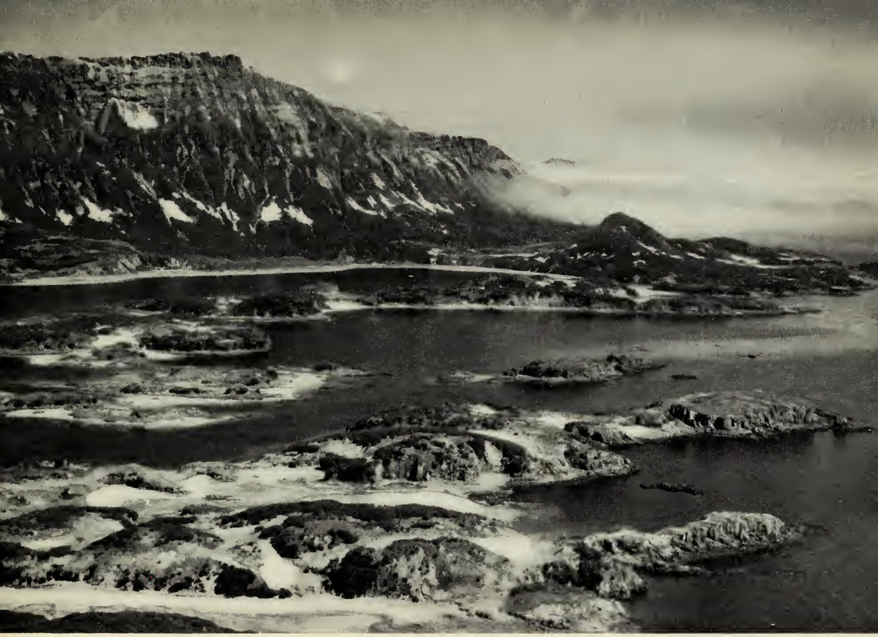
FLOWER-DOTTED ARCTIC MEADOWS SURROUNDING LAKES LIKE SCHRADER AND PETERS ARE NESTING GROUNDS OF WILDFOWL THAT WINTER IN THE UNITED STATES.

Magnificent Katmai

FROM THE AIR *By LOWELL SUMNER*

(Above) Cape Kubugakli, southern boundary corner of the monument. The lagoons are havens for waterfowl and huge king crabs. Game trails are everywhere in evidence . . . *(Below)* Low Katmai Valley, and the broad bay, are still clogged with ash and pumice from the eruption. The forest has not yet reappeared. This view looks out over Shelikof Strait to distant Kodiak Island.

Dakavak Bay was protected from the eruptions by ridges. In its friendly valley we saw the first of many Alaska brown bears. . . . At Geographic Harbor's upper end there is a fresh-water lake. The enclosing walls are so steep it is almost incredible that they could be densely clothed with alders.

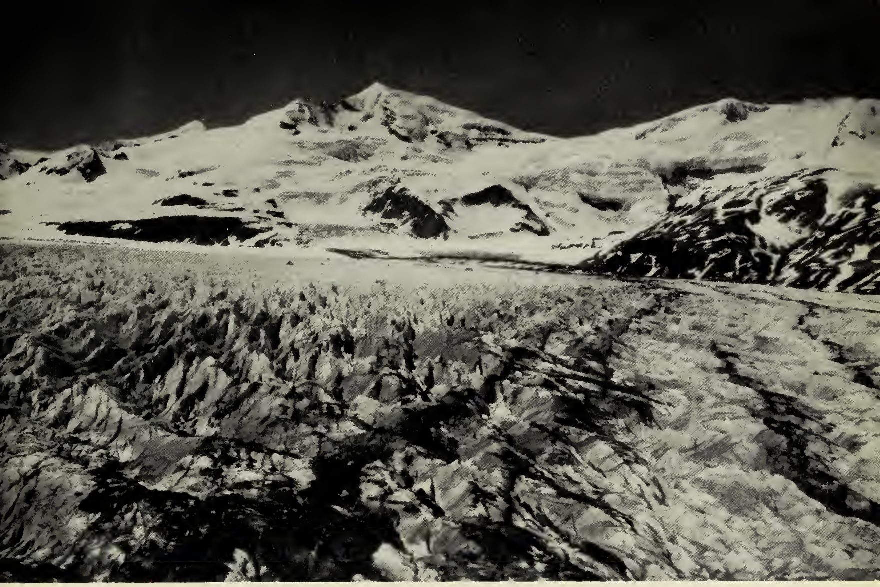


These low, glaciated promontories guard the entrance to Geographic Harbor, but there are channels deep enough for large vessels to enter. . . . Around Kukak Bay, spires of rock are favorite sites for the great stick nests of American eagles. Accustomed to supremacy in the air, they watched us, like this one whose white head is visible in the nest, but did not fly away.

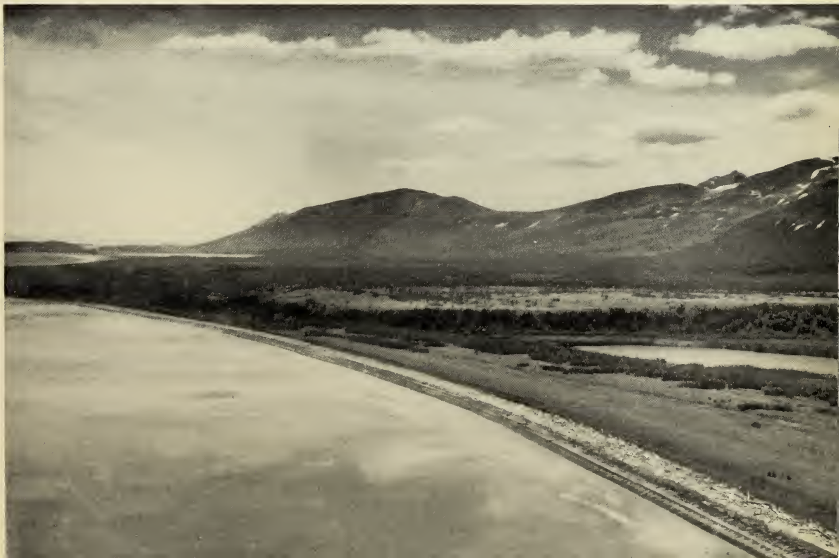
In Kukak Bay three Alaska brown bears floundered and slid in their haste to climb the steep, loose gravel. We counted ten from the air in about an hour. . . . . Missak Bay's long beaches, grassy slopes and dense alder jungles have remained undisturbed, in the possession of the bears.

Inside the narrow entrance to Geographic Harbor is a spacious anchorage. Not snow but pale yellow ash from the eruption makes this variegated pattern with the dark green vegetation. . . . Each of Kukak Bay's three valleys is a separate, unexplored wilderness. Running almost at sea level, the left one almost connects with Kinak Bay through a low divide.

Back of Hallo Bay this wilderness of cottonwood groves, ponds, swamps, jungles of alder and willow, and low grassy ridges is a summering ground for waterfowl and shore birds; a year-round home for beaver, mink, foxes, occasional wolverines, and the ever-present bears. . . . On rolling, sheltered benches near Kukak Bay, where groves of spruce and birch alternate with open grassy places, a bear can doze undisturbed in the shelter of these rocky banks.



Hallo Glacier, coming down from the icefields of Mount Denison (7,600 feet) and Kukak Volcano. . . . Up the coast from Hallo Bay, long, straight beaches lead to the tiny clam-digging settlement of Kaguyak.

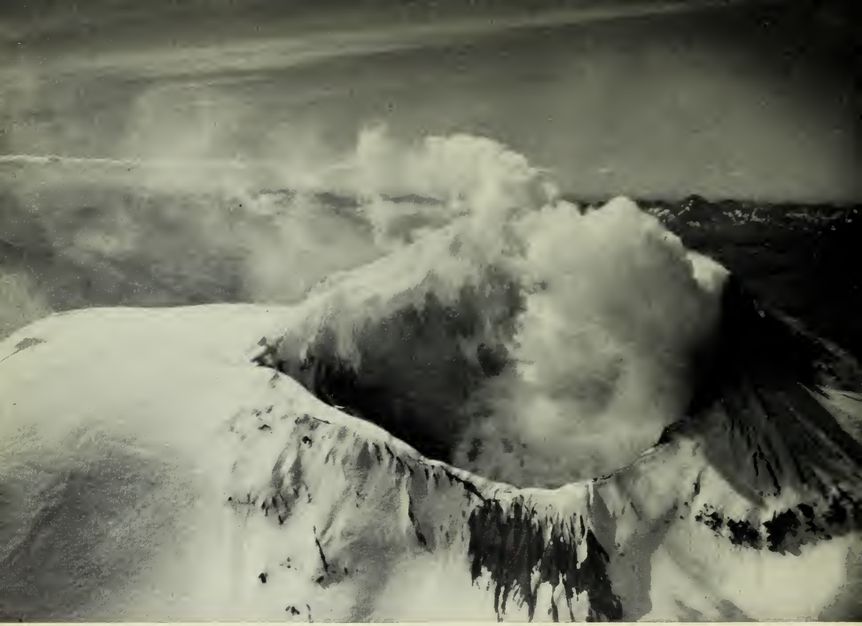


An unexplored, partly wooded valley, dotted with occasional ponds, penetrates far inland from Hallo Bay, around and almost behind the Devil's Desk. . . . Kaguyak, a collection of about six shacks, is occupied during the summer months. Driftwood for fires lies everywhere along the coast. The razor clams dug here at Kaguyak at low tide are eight to ten inches long.

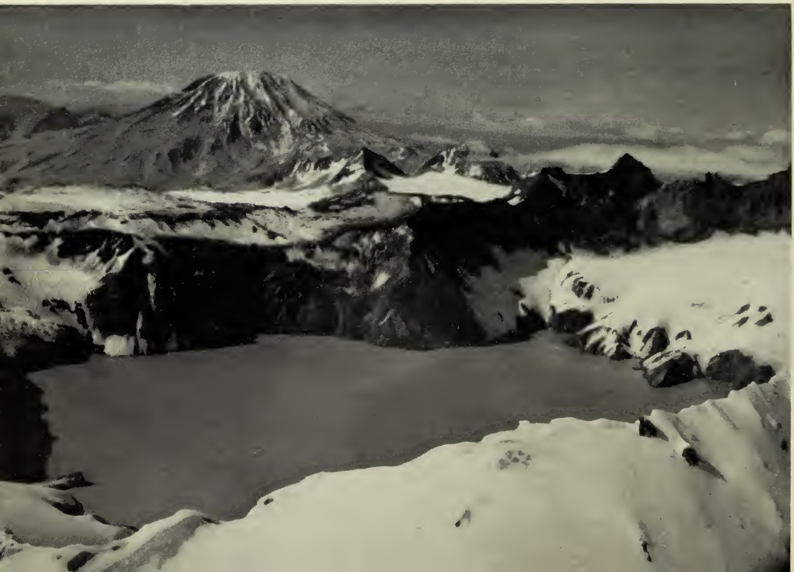
In the Kaguyak region is an almost unknown crater, approximately two miles across, and brimming with water. Photo by A. C. Kuehl. . . . The rock-bound peninsulas and offshore islets of the Cape Douglas section of the monument are like a magnification of the Oregon and Washington coast.

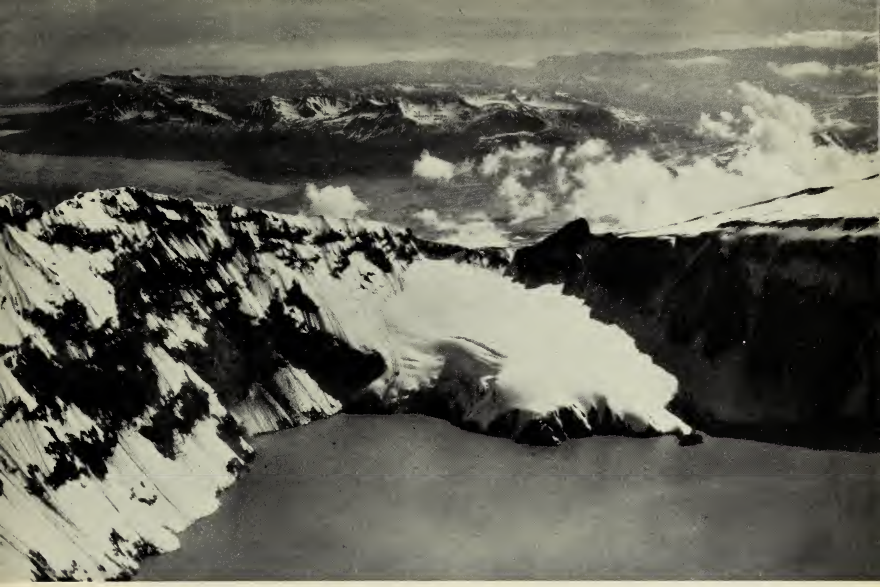
Devil's Desk region, looking southeast from the Douglas River valley over the narrow neck of the monument toward distant Kodiak Island across Shelikof Strait. . . . Brooks Falls is known for the fly fishing in its vicinity.

Beautiful Brooks Lake (foreground) is only a half mile from Lake Naknek (background), with which it is connected by the broad, swift-flowing Brooks River, famous for its great fish and for the beauty of its falls. . . . Among groves of cottonwoods at the river's mouth is Brooks River Camp, present headquarters for Katmai National Monument.

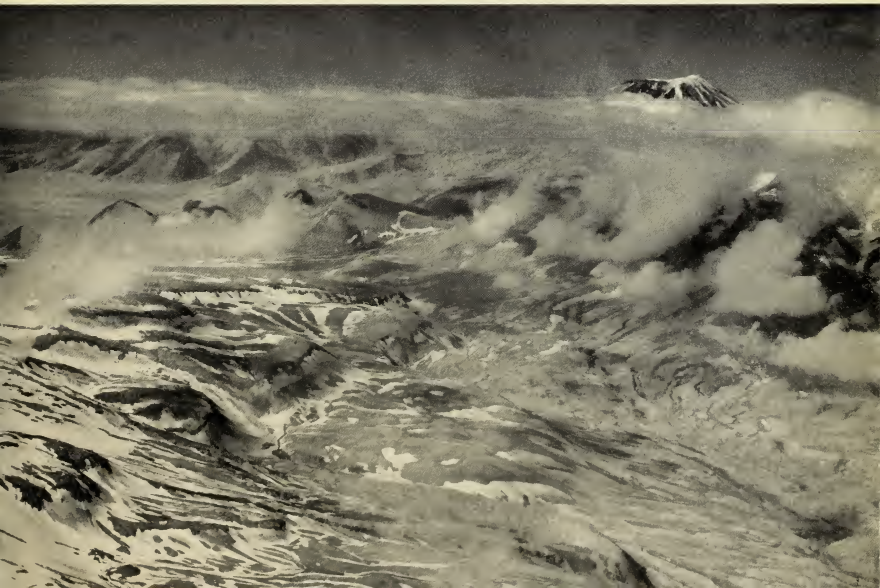


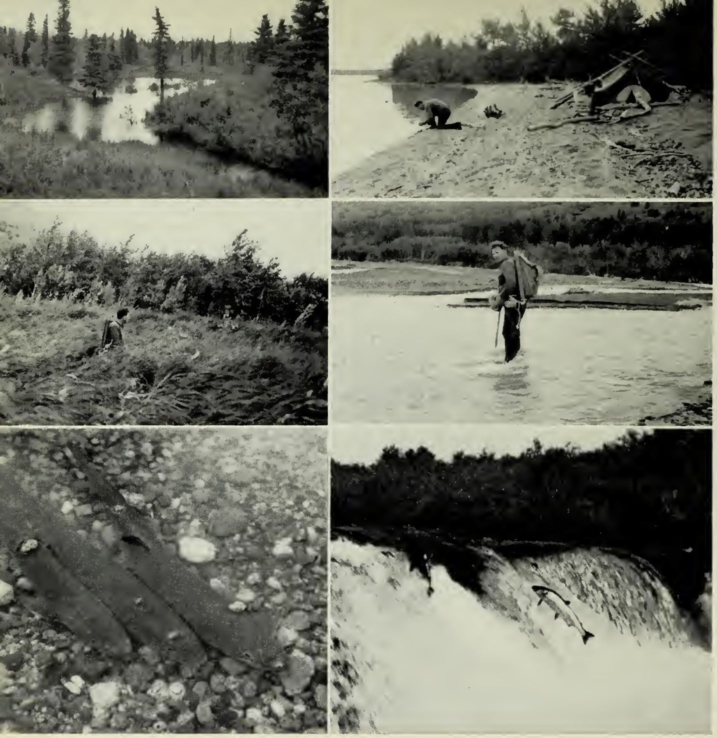
Ever since the eruption of the Katmai region in 1912, clouds of steam and sulphurous gases have billowed steadily from Martin Volcano's cavernous throat. . . . Exploded Mount Katmai's jagged-rimmed bowl is more than two miles across. Contrasting with the dark rock of its towering inner walls is this mile-long lake of unbelievable jade green. Photo by Adolph Murie.



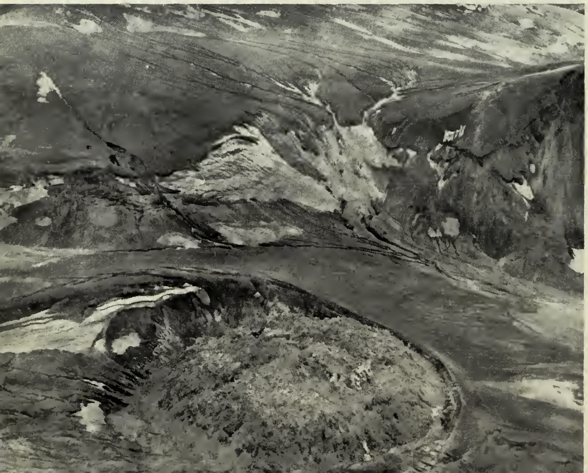


Inside Mount Katmai's crater the horseshoe-shaped island that Griggs once saw has been covered by the rising waters, and new glaciers have softened many of the rugged contours. . . . Beyond desolate Katmai Pass (center) and the flank of cloud-draped Knife Peak lies the desert Valley of Ten Thousand Smokes (far left).



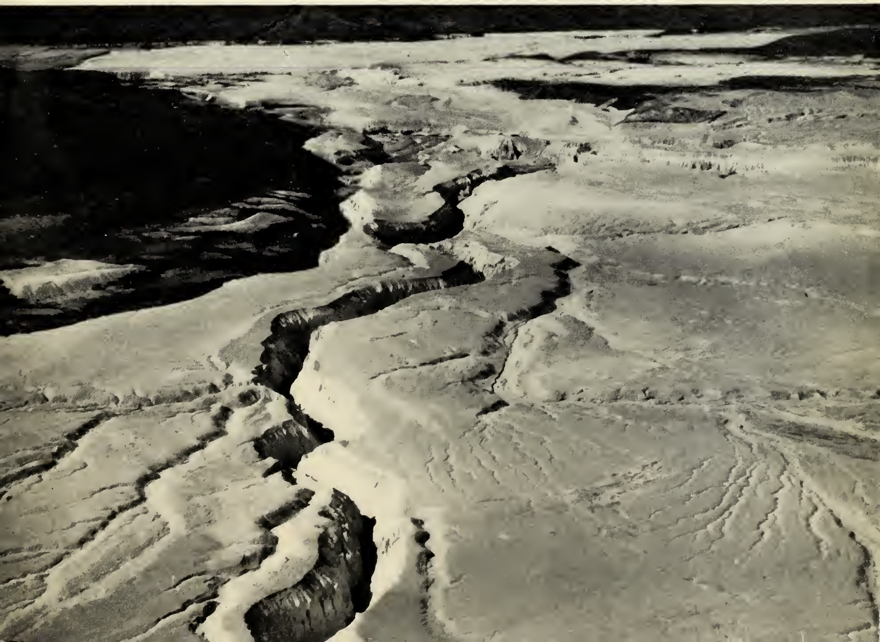


(1) Spruce woodland on stream flowing into Naknek Lake; (2) camp on Naknek shore; (3) on old "trail" (overgrown with four-foot grass) to Valley of Ten Thousand Smokes; (4) fording Ukak River—by A. C. Kuehl. (5) A lake trout and two rainbows, Lake Coville—by George L. Collins. (6) Salmon leaping Brooks Falls—by Northern Consolidated Airlines.



Novarupta Volcano, Valley of Ten Thousand Smokes—by Northern Consolidated Airlines.

Seals, marine birds, and occasional sea otters inhabit Katmai National Monument's coastal section. Cape Douglas in background. . . . Smooth enough to ride a bicycle on in 1919, the valley floor now is fissured by pink-walled canyons two hundred feet deep cut by the Ukak River and its tributaries.



This lonely collection of ancient, half-flattened log structures (barely showing in the clearing) is all that remains of Savonoski, abandoned in terror by the natives at the outset of the eruption. . . . Fisherman's view of the Brooks River, downstream from the falls.

are being used with increasing frequency to travel overland for hunting purposes.

Wilderness values in Alaska are being impaired in other ways, often quite unnecessarily. Anyone familiar with the wet tundra knows that the passing of a single vehicle during the warmer months makes a scar that remains for years. Great areas along the Arctic Coast have unfortunately been defaced in this manner.

A few of the Federal agencies make it a practice to discard empty steel drums and other indestructible debris along transport routes in the Arctic. In fact, much of the Arctic Slope in the Naval Petroleum Reserve is well on its way to becoming a gigantic dump.

Since 1949, I have spent much time in the central part of the Brooks Range, and have often camped with the Eskimos along the shores of a lake situated in a broad valley. In the spring of 1956, I was much disturbed to find that the most interesting area had been used as a gasoline dump by one of the Federal agencies concerned with topographic surveys. Large numbers of gasoline drums had been dropped from a cargo plane for use by ground personnel, and of course the drums were left when the work was completed. Here was a situation where a few irresponsible white men had done more in a day to disfigure the wilderness than the Eskimos had been able to do in many generations.

It is indeed well that we have some special reservations, though all too few, where regulations ensure the preservation of the country and the wildlife in a natural state. I should like to review briefly the status of some of these areas, which fall into three categories—National Parks and Monuments, National Wildlife Refuges, and National Forests, the latter two being multiple-use areas of great importance to a variety of interests.

NATIONAL PARKS AND MONUMENTS

Three areas under the control of the National Park Service have great value as wilderness areas and are becoming increasingly important for recreation.

Mount McKinley National Park (area: 3,030 square miles). Situated in the Alaska Range, this Park has spectacular mountains and glaciers and is the only area of interior wilderness that has been set aside for preservation. It is the only easily accessible place in Alaska where tourists can expect to see most of the species of large animals at close range.

Previously accessible by rail or plane only, the completion of the Denali Highway in the fall of 1957 made it possible to drive to the Park. In 1956, the Park was visited by about 6,000 people. In 1957, when the road was first opened, there were about 11,000. There were 26,000 people in 1958, and ever increasing crowds can be expected in the future.

Katmai National Monument (area: 4,214 square miles). Established to preserve the area affected by the volcanic eruption of 1912, it contains spectacular wilderness and abundant wildlife.

In a release last February to the Associated Press, Senator Bartlett advocated a reduction in the size of Katmai National Monument. He considers the area to be excessively large and wants to eliminate land which he defines as "not up to Monument standards." Senator Bartlett's view was strongly supported in an editorial in Alaska's largest newspaper, the *Anchorage Times*, which pointed out that the region was inaccessible and rarely visited by Alaskans.

There is no evidence that the Monument contains valuable minerals, and certainly this land is not needed for homesteading or other agricultural pursuits.

Glacier Bay National Monument (area: 3,554 square miles). This is a region of spectacular mountains and glaciers, with abundant wildlife. The Monument preserves an area of coastal forest in all stages of post-glacial development. Although not now accessible by highway, it can easily be reached by boat or plane from cities in southeastern Alaska.

NATIONAL WILDLIFE REFUGES

There are fifteen National Wildlife Refuges in Alaska at the present time. Largest is the *Aleutian Islands Refuge* (area: 4,250 square miles). Established in 1913 to protect sea otters and other wildlife, the Refuge includes all of the Aleutian Islands except Umnak, Unalaska, Akun, Akutan, and Tigalda. Of the islands in the Refuge, Atka has Aleut villages; an active airfield is found on Shemya; Adak has a large naval base. Several of the islands have deserted military installations that are rapidly deteriorating at the present time.

Unimak, the largest island and first at the end of the Peninsula, has a continental-type fauna. During the time fur farming was widely practiced, arctic foxes were introduced on several of the islands, and they still remain in most cases. Rats also have been introduced, and they have become feral. Ten caribou were placed on Adak Island in 1958, so there would be hunting for the benefit of Navy personnel. The executive order by which the Refuge was established provides for military use of the islands whenever considered necessary.

A proposal to withdraw all tidelands and adjoining areas of water extending three miles beyond low tide line in the Aleutian Islands Refuge, to permit more effective management of sea otter, was published in the *Federal Register* of October 23, 1958. However, Senator Bartlett considers the tidelands to be state property and has urged that this order be withdrawn.

Bering Sea Refuge consists of Hall and St. Matthew islands and Pinnacle Rock, with a total area of 64 square miles. This Refuge was created in 1909 for the protection of sea birds. These are mountainous islands with a maritime climate and arctic-type flora. Two species of indigenous land mammals are present.

Reindeer were introduced in 1942 for the use of military personnel stationed on St. Matthew during the war. I think twenty-four animals were originally introduced, and in 1954 I estimated the population to be 600; a census made in 1957 by Fish and Wildlife Service personnel disclosed about 1200 animals. The rapid increase of these reindeer will have serious effects on the vegetation, but they are being left so that observations may be continued. I am strongly in favor of removing the reindeer. These islands are very rarely visited and will retain their original character unless the reindeer cause irreparable damage to the vegetation.

Kodiak Island Refuge, with an area of 3,046 square miles, was established in 1941 for the protection of brown bear. The entire population of a unique form of brown bear is restricted to Kodiak Island and the neighboring islands of Afognak and Shuyak which lie to the north. The Refuge is important to migratory waterfowl. Sitka black-tailed deer are abundant, mountain goats have recently been introduced along with several species of smaller mammals, and there is some evidence now that the elk introduced on Afognak Island are crossing over to Kodiak.

A few small installations connected with fisheries research operate within the Refuge, and some of the guides maintain hunting cabins, but these detract little from the wilderness value of the Refuge. Recent boundary changes placed a mile-wide strip around the Refuge under control of the Fish and Wildlife Service, thus forestalling inappropriate use by private interests.

Much of the land outside the Refuge is occupied by cattle ranchers, who lease public land for a negligible fee. This industry is handicapped by inadequate winter range and by lack of a market for the unfinished beef produced. It is quite evident, from a purely monetary standpoint, that Kodiak Island can best produce bears.

Pribilof Islands Refuge, consisting of 78 square miles, was established in 1910 for the protection of the breeding grounds and management of fur seals. The two main islands, St. Paul and St. George, comprise the breeding grounds of a fur seal herd numbering about one and one-half million animals. There are also great colonies of sea birds, and about three species of smaller mammals, as well as colonies of Steller's sea lion.

The Refuge is managed by the Bureau of Commercial Fisheries and no change in its status is anticipated.

Nunivak Island Refuge contains 1,733 square miles that were set aside in 1929 for the protection of muskoxen.

The mountainous island now supports a herd of about 140 muskoxen, which are the descendants of 34 animals introduced from Greenland in 1930. Also present is a large herd of reindeer now being managed by the Federal Government and probably soon to be placed under the control of the Eskimos, of whom there are about 300 inhabiting the island. Serious damage to the range resulted earlier from the numbers of reindeer which were at one time excessive. Waterfowl and large colonies of cliff-nesting sea birds are numerous.

Bogoslof Island Refuge, six-tenths of a square mile, was established in 1909 and is one of the few places where Steller's sea lion is protected. Sea birds are numerous here.

Simeonof Island Refuge of 16 square miles, an island in the Shumagin Group, was set aside in 1958 to protect sea otter which are beginning to be numerous in this area. The island itself will be leased for grazing.

Kenai Moose Range consists of 2,894 square miles established in 1941. The range includes one of the most intensively used recreation areas in Alaska, since it is easily reached by highway from Anchorage. The northern half of the refuge, comprising about 1790 square miles, has been opened for oil exploration. Three wells have been drilled and two are in progress. An effort is being made to consolidate the installations so as to retain the undisturbed areas in as large tracts as possible. The personnel of the oil companies have shown a cooperative attitude and have expressed the intention of interfering as little as possible with the wildlife resources.

The major nesting grounds of the trumpeter swan in Alaska are included within the area open to exploration. Fish and Wildlife personnel observed about twenty nests in 1958 and found no evidence that any had been disturbed by activities connected with the oil development.

Since the spruce forest is the climax vegetation here, management of the refuge for moose productivity requires the development of winter range. It is planned to restrict habitat modification to areas already disturbed by the explorations for oil or by roads, or to areas of maximum public use. In 1947, a fire burned about 290,000 acres of the Refuge, and the following replacement of spruce by willow, aspen, and birch greatly improved the habitat for moose.

The southern half of the range, about 1100 square miles, will be maintained as a natural area. This includes the upper moose range, the sheep range, and is an area of spectacular mountain scenery.

Besides the Wildlife Refuges I have mentioned, several small reserves have been established to protect sea birds or waterfowl. These are Chamisso Island, Forrester Island, Hazen Bay, Hazy Islands, St. Lazaria Island, Semidi and Tuxedni Islands. All of these are quite remote and rarely visited.

NATIONAL FORESTS

There are two National Forests in Alaska; *Chugach National Forest* has an area of 7,502 square miles and includes Afognak and Shuyak Islands which lie north of Kodiak, the eastern portion of the Kenai Peninsula, and also the Prince William Sound region with all of the islands of the Prince William Sound Archipelago.

The portion of the Forest on the Kenai Peninsula is traversed by the Seward Highway and the upper Sterling Highway; it is near the major population center of Anchorage and consequently is an important recreation area. The proposed Copper River Highway will pass through the National Forest to Cordova which is a small town on Prince William Sound.

Tongass National Forest has an area of 25,072 square miles and includes most of the mainland of southeastern Alaska as well as the islands of the

Alexander Archipelago. Several towns lie within the forest, including some large Indian villages.

PROPOSED REFUGES

In addition to the aforementioned reservations, the Department of the Interior has proposed the creation of three new wildlife refuges.

The *Kuskokwim Refuge* would contain 2,924 square miles of wet tundra which has great importance as a breeding ground for waterfowl. No management is proposed here, and no detrimental use of the area is foreseen. This region is uninhabited, although some hunting and trapping are done here by the Eskimos. The establishment of this refuge has received considerable opposition and almost no public support.

The *Izembec Refuge,* also for waterfowl, would contain 680 square miles. A small military reservation is in the area and it is bordered on the south by an active airfield. No physical development of the area is planned.

The proposed *Arctic Wildlife Range,* with an area of 10,000 square miles, would encompass portions of the Arctic Coastal Plain and the highest peaks of the Brooks Range, a region of rugged mountains, lakes, and tundra, and would extend into the boreal forest zone of the south slope of the Range. Here, in the Romanzov Mountains, on Mounts Chamberlin and Michelson, are found the only glaciers in northern Alaska. The fauna of the area is remarkably abundant, and the species of arctic plants are well represented.

The reestablishment of the muskox, which has been extinct as an indigenous mammal in Alaska for more than 70 years, is planned. To quote Ross L. Leffler, Assistant Secretary of the Department of the Interior, "The Arctic Wildlife Range should be administered for the protection of wildlife and wilderness recreation values, and scientific studies in designated research areas would be encouraged to promote the maintenance of undisturbed ecological and wilderness conditions." Hunting and trapping would not be restricted in this area, nor would there be any restriction of mineral exploration, development, or removal. Any such developments would have to be limited to the areas of proven mineral claims, and this of course precludes many objections that would otherwise arise.

I should like to emphasize that the United States does not have a single arctic area set aside for preservation. The future scientific and cultural value of such an area is self-evident, and it would be an incalculable loss if establishment of this reservation is prevented by relatively few people concerned with the possibility of immediate economic gain. However, the Alaskan State Legislature on March 14 passed a resolution against the establishment of the Arctic Wildlife Range. With the exception of the Tanana Valley Sportsmen's Association, which expressed support for the Range, little public support has been manifested, but many individuals who have expressed no opinion publicly also favor its creation.

The three proposed refuges would add a total of 13,725 square miles to the established reservations. Many of these reservations have already provided opportunities for important basic and applied research in biology and other fields. Such areas will have much greater importance when few suitable unprotected regions remain.

I should like to mention briefly the status of certain species of wildlife in Alaska, based largely upon information from personnel of the Fish and Wildlife Service.

The last four winters have been remarkably mild, with the result that there has been good survival of moose and caribou. The caribou herd in the Nelchina area, about 200 miles northeast of Anchorage, numbers at least 45,000 animals. Since the annual kill never exceeds 4000 animals, the size of the herd is rapidly increasing. As pointed out by Leopold and Darling in 1953, there is a continuing danger that the winter range will be depleted. The herd is already moving much farther to the west during the winter months, and many animals are now found well into the Talkeetna Mountains which lie northeast of Anchorage. The possibility exists that a large portion of the herd may move into the Mount McKinley area and for all practical purposes become unavailable to hunters. The numbers of the Steese Highway herd in eastern Alaska have decreased because many animals have remained in northern Canada. The herds on the Arctic Slope are increasing and gradually invading regions from which they have been absent in recent years.

Moose are quite abundant south of the Alaska Range, where both reproduction rate and survival rate have been high. Moose appear to be extending their range in all directions—for the first time last spring several were killed even in the vicinity of Point Barrow which is certainly far from their usual habitat. In most cases, wandering animals are killed before a population can be established in new areas.

Elk on Afognak Island have increased from only 8 in 1929 (when they were introduced) to a herd of 800 animals; 111 were killed in 1958 by a total of 345 hunters.

Sitka deer, goats, and sheep seem generally to be maintaining their numbers. The Sitka deer are becoming abundant in some areas, such as on Kodiak Island.

There has been some indication that brown bears have decreased on the upper Alaska Peninsula during the last two to three years. The population compares favorably, however, with that of the brown bears on Kodiak Island, as shown by observations in 1958 on sex and age composition. The illegal killing of bears, especially by fishermen, is a serious problem, since this is done commonly wherever bears are vulnerable. Most of the cattlemen on Kodiak attempt to kill every bear they see, without determining whether or not the animals are cattle killers.

Hunting of brown bears by airplane in early spring is now largely prevented by slight adjustments in the time of the open season. Some changes in open season are also contemplated on Kodiak Island in order to reduce the kill of female bears.

Despite the bounty on wolverines, there has been apparently no significant decrease in their numbers. Some remedial legislation is needed to stop the killing of these animals from planes.

Wolves are intensively hunted by means of airplanes. The Nelchina area has finally been closed to wolf killing, and personnel of the Predator Control Division of the Fish and Wildlife Service have been investigating the movements and other habits of the single pack still present. This pack included ten animals until the recent kill of three near the boundary of the closed area. It is now proposed to enlarge the refuge, so as to afford the remaining animals more adequate protection. I believe that approximately 200 wolves were killed in this area over the preceding years.

Predator control is being continued, though on a somewhat reduced scale. Nothing is being done on the Arctic Slope, but this advantage is offset by the amount of bounty hunting by private individuals using small planes. Small planes from as far away as Anchorage engage in hunting wolves in the Arctic, and many animals are killed annually in this way.

The almost complete lack of information on the bionomics of polar bears makes any statement as to their status purely speculative. It has never been established whether the same individual animals are hunted throughout the circumpolar regions whenever they approach inhabited lands. The take of polar bears in Alaska has increased annually during the last few years. Almost all hunting is accomplished by the use of planes; some based in Arctic Coast villages and others from as far away as Anchorage work out of villages such as Nome, Kotzebue, and Point Hope. Since the hunts take place over international waters, sometimes as far as 200 miles from land, regulations are very difficult to establish and enforce.

Walrus probably need additional protection. The annual kill appears to be excessively large, and hunting techniques and utilization are grossly inefficient. Better control over the hunting activities of the Eskimos would be desirable. Sport hunting of walrus has been permitted during the last year or two, but the kill is much too small to have any significance. The Department of the Interior has planned to investigate the possibilities of an international agreement which might lead to better management of both polar bears and walrus.

During the last few years, the U.S. Fish and Wildlife Service and the Territorial Department of Fish and Game have had joint responsibility for the wildlife resources, although the Territorial organization had little authority. This arrangement led to some unusual situations; as an example, the wolverine is a fur-bearing animal according to Federal law, but a bounty was placed on wolverines by the Territory. Consequently, killing a wolverine out of season for the bounty was a punishable offense, whereas a bounty was paid when the animals were legally taken as fur animals during the open season.

The State will probably gain control over wildlife resources in about January, 1960, but before this is realized, it must be demonstrated to the satisfaction of the Secretary of the Interior that adequate provision has been made for the administration, management, and conservation of these resources in the broad national interest. This wise requirement should do much to ensure a carefully prepared program.

The bill which would create the Alaska Department of Fish and Game apparently is now awaiting the acting governor's signature, and I have not read the final version. However, it was based upon a model bill drawn up by the International Association of Game, Fish, and Conservation Commissioners, with certain changes adapting it to Alaskan conditions. In the latest form of the bill, the proposal for a Fish and Game Commission has apparently been deleted.

Although the administrative organization is somewhat indefinite, the new department is expected to have five divisions which will be concerned with game, sport fish, commercial fish, biological research, and enforcement. The State will be divided into at least three major management areas.

During the last year, the Territorial organization has attempted to recruit well-trained men, all of whom will continue on in the State's Department. A small number of experienced biologists will transfer from the Fish and Wildlife Service; most of these had been supported by Pitman-Robertson funds in the past. The Game Division plans to hire twenty biologists during the first year and expects to have a staff of forty biologists within three years.

On July 1, the Alaska Department of Fish and Game will become eligible for Federal matching funds under the provisions for Federal Aid. A maximum of about $850,000 will be available for game, and about $250,000 for sport fish; but since it is improbable that Alaska can match all of the Federal Aid money available, the Game Division expects a maximum of about $400,000 during the first year. A bill also has been introduced to provide licensing of hunting and fishing, with a suggested schedule of fees and the revenue anticipated, which is expected to amount to about $569,000, or about sixty-five per cent more than license collections in the fiscal year 1958. The expected revenue will probably be retained within the Department of Fish and Game.

The Division of Biological Research will be concerned mainly with basic investigations and consequently will not be eligible for Federal Aid money. It will be supported initially by appropriations, but I shall not attempt to predict how adequate such funds might be. Predator control will fall into this Division, as now planned. The Department does not expect to support a general predator control program but intends to initiate some investigations of predator-prey relationships. The State organization also will specify when, where, and how the Fish and Wildlife Service predator-control personnel will operate.

A very tight budget may assist toward eventual elimination of the outmoded bounty system. Just recently, the Legislature appropriated $107,500 of a pro-

Wildlife and Alaska

Alaska's scenery is incomparable, a continent's highest, iciest, wildest. Yet it can seem almost cheerless and sterile, as Mount McKinley's massif is, even though softened by a foreground of grass and trees. Add wildlife to the scene and something happens—something very vital.

We don't have to add it. It is there. The great bears and fighting fish, the moose, sheep, and caribou still know the long northern days and nights, still have an unquestioned right to be in their wilderness world, to live and die there.

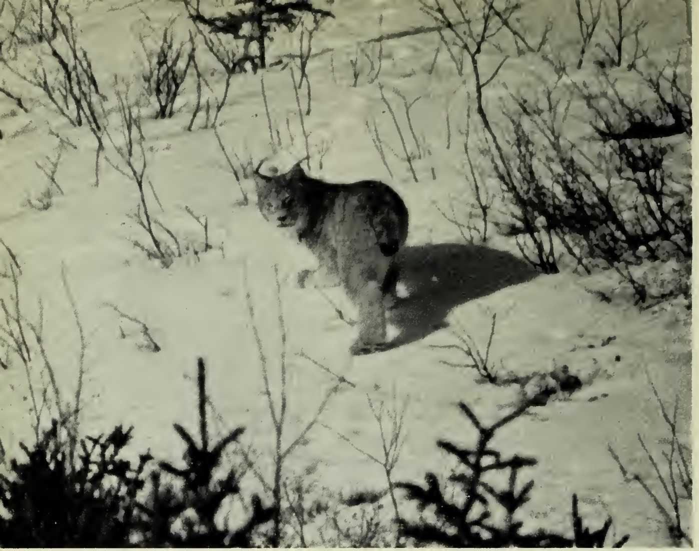
Man can change all this, but need not. He may do it by mistake if he does not consider what is there, and the meaning of it.

photographs by Warren Steenbergh, Charles J. Ott, and Herb and Lois Crisler

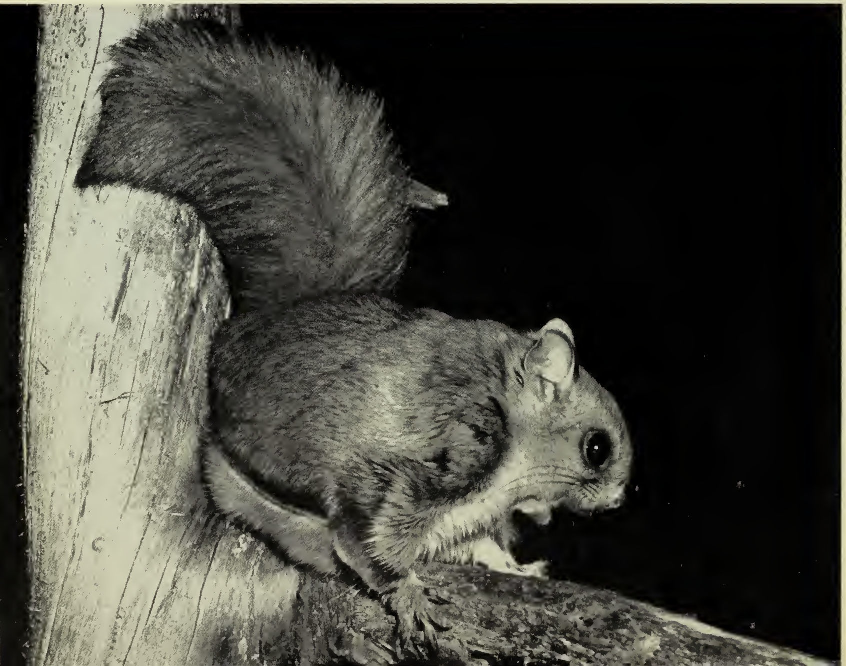
legends by Lowell Sumner

The Alaska red fox cannot hibernate, nor can he browse at leisure on nature's stationary bounty of grass and twigs. To survive, he must be quicker and smarter than the small animals on which he feeds. . . . More prolific than intelligent, the rabbit and rodent tribes support a small aristocracy of cunning predators. To elude these, the snowshoe hare turns white in winter and brown in summer.

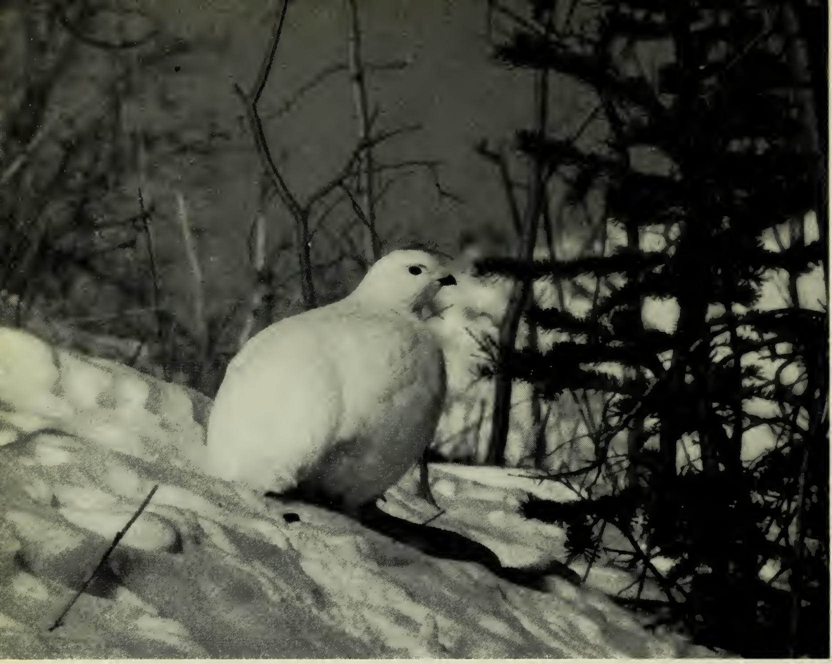
The long-tailed jaeger, cousin of the gulls, is a bold, hawk-like hunter. . . .Through the simple virtue of rapid multiplication, the red-backed mouse and his cousins, the lemmings and meadow mice, easily hold their own against the North's intelligentsia—fox, coyote, lynx, wolverine. . . . The horned owl, large as a rooster and with the claws of an eagle, is a courageous, mighty hunter. Game is not appreciably diminished by this owl when food and shelter are adequate; otherwise mortality is high—equally high from other causes if all the owls are removed.



The lynx needs extra big, heavily furred feet for long wanderings through the deep snow—and much patience in stalking for the winning of a meal of rabbit, mouse, or ptarmigan. . . . Soft-furred as a chinchilla, the dainty flying squirrel (shown here scolding) glides expertly with the help of a parachutelike membrane extending from wrist to ankle. Its nocturnal habits have freed it from attack by hawks and other daytime predators, but not from the horned owl.

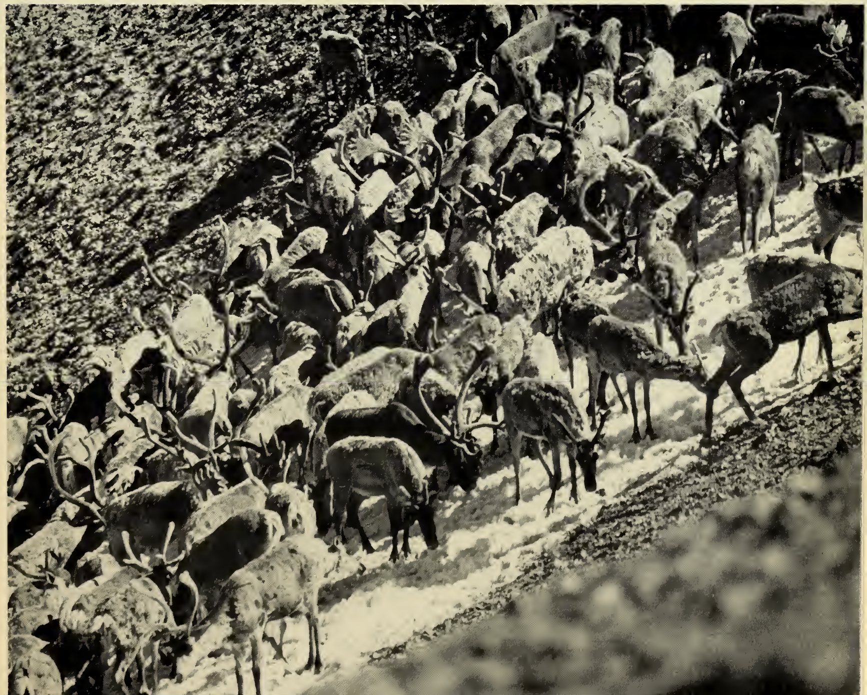


The coyote must live by wits and skill. In summer things go very well following the appearance of a vast new generation of mice, rabbits, ground squirrels, and other creatures young and dumb, but by winter the cream of the summer food crop has been skimmed off, and some competitors like the wolf are more powerful than he. His wonderful wild music gives the touch of perfection to a campfire evening. . . . An inquisitive beaver observes human behavior.



The willow ptarmigan turns snow white in winter to elude the fox, lynx, and other hard-pressed enemies. The spring molt brings to this ground-nesting bird a brown dress to blend with the tundra and the willow thickets. . . . The parka or ground squirrel is a principal food of the coyote, wolf, wolverine, and grizzly. For nine months of the year he hibernates safe in frozen ground, and his summer's rocky homesites also make hard digging. Although no strategist of escape, he is alert and quick; above all he is prolific. . . . Northern phalarope. The female is larger and brighter than the male and leaves the care of the eggs to her spouse.

In Alaska, caribou in primeval numbers now survive only in the remote Arctic, which is too wet to burn and has not yet been substantially invaded by man. Here the lichen crop, the wandering caribou hordes, and the wolves still maintain their original natural balance. Caribou often stand nose down on snowbanks in summer because the cold air deters the hordes of flies and mosquitoes.



Although the wolf is the swiftest and most powerful of the northern hunters, he too must depend for survival upon sagacity and teamwork. All but the youngest caribous, if in health, can run faster; Dall sheep can elude him among the crags; moose can stand him off unless hampered by deep snow. The myth that the wolf is an arch villain, dangerous even to man, slowly gives way to the modern concept that this animal is an important natural tool for controlling the numbers of game animals in remote northern regions: wolf numbers can be allowed to increase when the game animals increase, so

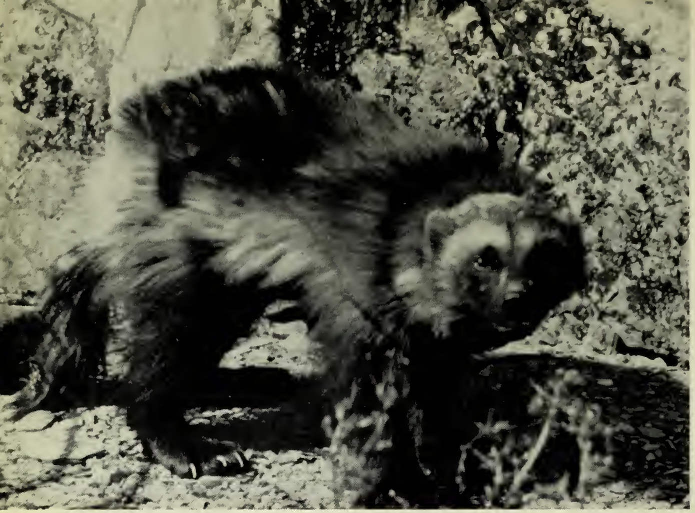
The Wolf

photographs by
HERB AND LOIS CRISLER

as to forestall destructive over-use of the natural range; should the game animals decrease, wolves then can be reduced in proportion. Significantly, the greatest abundance of wolves under natural conditions is precisely in those areas where game animals, especially caribou, also are most abundant and flourishing. The home life of the wolf is zestful and solicitous. Mutual affection prevails among family members, and this strong doglike affection also is shown toward human beings if young animals are tamed at an early stage, something the Crislers greatly enjoyed doing.

Among their crags, Dall sheep are safe from nearly all enemies but man. Severe weather is more dangerous than other animals. Dall sheep survive in greatest numbers in Mount McKinley National Park and in the Brooks Range.

The Arctic weasel holds down the population of creatures too small or too elusive for the larger predators. His agility and elongated shape allow him to penetrate the winter retreats of mice and pikas, which during the long winter months are safe from most other enemies. . . . Little chief hare and rock rabbit are other names for the pika or cony, a little gray guinea-pig-like inhabitant of the rock slides. Even the powerful grizzly seldom can dig the rock rabbit from his limitless fortress of crevices and crannies. Hibernation also is unnecessary, for the pika stocks his underground rock chambers with a winter supply of herbs and grasses.



The wolverine's survival depends on extraordinary endurance against cold and fatigue, dogged perseverance, and enormous strength for an animal no bigger than a yearling black bear. He will camp near a carcass and gorge at intervals until even the hide and most of the bones have been eaten. Of a single wolf he probably has no fear, but against sudden attack by several he must be alert to have an escape crevice among rocks or down timber, or a tree to climb. This wolverine, temporarily a captive, was tamed into eating from the hands of Mr. and Mrs. Herb Crisler. . . . The porcupine's quills are not an absolute protection. The quick red fox sometimes flips him over and attacks the soft underparts. The wolverine, wolf and lynx occasionally get him, at the price of a face full of quills.

The long summer days of the far North are a happy time of plenty and of zestful family life. Young red foxes frolic near their dens . . . and under mother's schooling young goldeneyes learn the rules for survival.

The grizzly's great strength and powerful claws are employed chiefly in digging. When he can find them, he digs up ground squirrels, marmots, and on rare occasions even young foxes. But his average daily fare is less ambitious—mice dug from their shallow burrows, berries in season, but especially roots and grass. In fact, the visitor's principal impression of the grizzly is likely to be of a peaceful plodding figure grazing on the tundra slopes like a cow or, as Alaskan's say, "like an old sow."

The snowshoe hare's brown summer coat matches his surroundings as well as the winter one. Disease epidemics reduce the populations every few years. Then their natural enemies, particularly the lynx, die off too, from malnutrition.

The moose has benefited from fires, which have replaced spruce forest and lichens with the browse and thicket cover that this animal requires.

Marmots often push and wrestle in play, and the young climb on their mothers' backs. Their lives seem easier than most. For nine months, they sleep deep in the frozen, rocky ground while lynxes, wolves, and their relatives must prowl without rest, and often starve. And in summer it is easy for a marmot to fatten on new grasses, succulent leaves, flowers, and seeds. But even a marmot must be alert lest he be cut off from his rocky burrow by the crafty strategy of wolf, coyote, lynx, or fox, or by an eagle swooping low over the brow of the slope.

Photographs by Warren Steenbergh: McKinley, fox, jaeger, mouse, owl, lynx, flying squirrel, beaver, parka, phalarope, caribou on grass, young foxes, golden eyes, grizzly, moose, marmots, and the trail-weary bear.

Photographs by Charles J. Ott: Hare, coyote, ptarmigan, caribou on snow, Dall sheep, weasel, cony, porcupine, showshoe hare.

By Herb and Lois Crisler: The wolves and the wolverine.

posed $143,000 to bring unpaid bounty claims up to date. It should not be too difficult for a good many people to realize that such funds could be much more effectively utilized.

It appears that the Enforcement Division will suffer from inadequate funds, and this may be one of the major weaknesses of the new organization. Much will also depend upon whether important positions are filled on the basis of qualifications or by political expediency.

The outlook for the establishment of state parks appears promising. The Bureau of Land Management has received $100,000 annually for the creation and maintenance of roadside campgrounds, and this money now will go to the state. About fifty exist and forty-two more are proposed. Three 5000-acre tracts have recently been set aside for state parks; these include part of the Lake George area, with the right-of-way from the Glenn Highway, an area along Eagle River near Anchorage, and the Worthington Glacier area on the Richardson Highway near Valdez. The State has the authority, over a twenty-five-year period, to select about 103 million acres from the public domain. Some of this land probably will be used for the establishment of recreational facilities. In addition, two special grants of 400,000 acres each, one of which involves National Forest land, have been made to the State for the purpose of community enlargement.

In the report of the National Resources Committee for December, 1937, Robert Marshall made the following statement: "Alaska is unique among all recreational areas belonging to the United States because Alaska is yet largely a wilderness. In the name of a balanced use of American resources, let's keep Alaska largely a wilderness!" Yet twenty years later very little of Alaska is a wilderness in the true sense of the word, and very few inviolable reservations have been established.

As a comparison, I should like to point out that the State of California, with an area of 158,693 square miles, has 37,771 square miles of reservations if one includes only National Parks and Monuments, National Forests, and State Parks. These reservations make up twenty-three and eight-tenths per cent of the area of the State. Alaska is three and six-tenths times as large as California, but has only one and four-tenths as much area set aside at the present time. Moreover, Alaska has a population of only 211,000 as compared with about 13,000,000 in California.

Fortunately for California, some of its earlier citizens had the foresight to set aside the natural areas which today are so highly valued. Many Alaskans feel that we should wait until the need is more evident before additional wilderness is preserved, not realizing that when everyone is convinced that such action is necessary, the opportunity will have been lost.

Unfortunately, many Alaskans are not well enough acquainted with the natural features of the State to realize how rapidly changes are taking place. Few people have the opportunity to travel in the remote regions and also many are not able to distinguish between seriously disturbed and natural wilderness, as long as all is green. That it is sometimes difficult to secure adequate popular support for proposed withdrawals of lands for conservation purposes is therefore not remarkable, particularly when one considers the adverse publicity such proposals so often receive in the Alaskan press. In view of this, it is encouraging that the proposed Arctic Wildlife Range, for example, has received the public support that it has in Alaska. Much of the credit for this goes to Olaus Murie and others who have been able to define the values involved in a strikingly understandable way. Nature conservation has enjoyed few advocates in Alaska, as compared with the many spokesmen for those who anticipate monetary gain through exploitation of natural resources. Since monetary values are so often the basis for action, let us hope that there will be an increasing awareness that the future economy of the State will benefit greatly from the tourists and others who are attracted by the recreational opportunities Alaska affords.

Alaska is now in a critical stage of its economic development. The desire and need for expansion in all phases of its economy conflict strongly with the aesthetic and scientific values to be gained by the provident institution of wilderness reserves inviolate to exploitation by the contemporary few, and which will retain their values unchanged for the enlightenment and enjoyment of ensuing generations. In conclusion I should like to emphasize a few points which seem particularly to require attention of conservationists:

1. Additional support is needed for the Arctic Wildlife Range and the Kuskokwim and Izembec Refuges.
2. It will be necessary to guard against possible demands of special interest groups who may desire access to certain reservations to the detriment of the national interest. The National Monuments are most vulnerable. It would be highly desirable to make National Parks of both Katmai and Glacier Bay National Monuments. The potential value of these Monuments as recreation areas can be visualized when one considers the increasing utilization of Mount McKinley National Park. Only 6000 people visited the Park in 1956; 10,600 in 1957; 25,900 in 1958. More are expected yearly.
3. The establishment by the new State of state parks.
4. Legislation must be encouraged to protect such species as polar bear, walrus, wolves, and others, which may not be able to withstand the effects of increased hunting or destruction of habitat.
5. Education in our public schools as to the values of conservation of natural resources is needed everywhere, but it would be especially helpful and appropriate now in Alaska, where the incompatibilities of development and conservation have been greatly emphasized.

Time still remains for the preservation of a few small fragments of primitive Alaska, but it is rapidly running out. If we do not persist more diligently in our efforts, assets of inestimable value will be irrevocably lost.

DISCUSSION

RICHARD M. LEONARD, *Discussion Leader*

LEONARD: There is one paradox that has always struck me as applicable to Alaska. We have lost part of our civilization in Greece, in Persia, in Spain, in India, and so often the people have thought it was God's handiwork, or the devil's, or somebody's other than their own. It occurred over a long enough period of time so that they blamed other causes. Paradoxically, in America we have destroyed our resources so rapidly that we have been able to see that it is our own causes; cause and effect are close enough to be able to discern. Now in Alaska, as Dr. Rausch has pointed out, you can see that process accelerated again. The problem we have before us is how to temper that and how to apply the lessons we have learned in the rest of the United States—and in the Near East, in Spain, in Egypt, in India, and elsewhere—to the relatively new country of Alaska.

ROSCOE POLAND (San Diego): Perhaps I have misunderstood, but did you say that in order to protect the salmon in some localities they resorted to dynamiting seals?

DR. RAUSCH: That is right. In southeastern Alaska, where the channels are suited to that type of operation, it has been the practice to use dynamite in the deeper water when seals are passing through. In that way large numbers are killed.

POLAND: Who does this?

RAUSCH: I believe the former Territorial authorities were doing that. Whether the State personnel will continue I do not know.

LEONARD: Do you have information, or does anyone from the Bureau of Land Management know exactly what is the present status of the Arctic Wildlife Range? You mentioned that it needs support, and I recognize that. What legal steps are still to be taken to make it a more permanent actuality?

RAUSCH: I have not heard the latest information about that.

LEONARD: Is there anyone from the Bureau of Land Management here who could give us information on that?

HOWARD ZAHNISER (Executive Secretary of the Wilderness Society, Washington, D. C.): Legislation is being prepared for introduction in Congress to give Congressional sanction to the establishment of the area. That has been expected for some time, but has not been introduced. In the meantime, there is a prevailing uncertainty. With regard to it, the best course would be recommendations to the Secretary of the Interior or to the House of Representatives or Senators.

LEONARD: I have always thought it was wise to support the Secretary with legislation, but it has always been my impression that the Secretary has not yet made the full legal proclamations that are available to him under law. Is that correct?

ZAHNISER: That is true.

LEONARD: The Secretary still needs urging on the part of conservationists to firm this up.

ZAHNISER: At the time of the first announcement of the Arctic Wildlife Range, assurance was given by the Department of the Interior that if legislation were not obtained, the Secretary would take those final steps. But for various reasons, legislation was not even introduced until the Eighty-fifth Congress, and then it was expected to be introduced in the Eighty-sixth but hasn't as yet been received there. That is about as much as I think it is discreet to say here—to convey the impression that the Secretary might be urged to lend his support to obtain legislation or take other action, and that representatives in the Senate and the House, both of whom we have touched, should be informed about the importance of it. I had not heard until this very excellent paper about the action of the Legislature in Alaska. The almost inevitable tendency of that would be to add to the difficulties in obtaining legislation in Congress, now that the Senate has on the Committee that would handle the matter representation from Alaska with that kind of background.

LEONARD: We are fortunate that we have in the Alaskan Legislature at least one conservationist, Grant Pearson, the former Superintendent of Mount McKinley National Park for approximately ten years. Grant is vigorously working for conservation, but that is only one voice out of a great many. In a new area like that they do need a lot of support, and fortunately we had a meeting of a small group of young folks from Alaska who want to form an Alaska conservation organization. They recognize as we do the need for having these views brought out to the Legislature by Alaskans, because for foreigners from California, Washington, or anywhere else to try to tell Alaskans how to manage their natural resource affairs would probably be not very tasteful. So if any of you who have friends in Alaska can help towards formation of such an organization it would be helpful.

ZAHNISER: I might add a reminder that the importance of the legislation, as the Secretary and others have seen it, is in this fact: at present, our Secretary could withdraw the area as far as the minerals are concerned. He could prohibit them or he could continue them, but he could not continue them in a modified way, subject to regulations. The Congress would have the authority to provide the kind of limited program they have in mind, so that if the Secretary depended on himself he could only prohibit, and that seems to be an impolitic thing to do.

OLAUS MURIE: I might say that when we were up there to look over that area, we met with many people throughout Alaska. As Dr. Rausch said, the Tanana Valley Sportsmen's Association was one hundred per cent with us and also two of the gun clubs near Fairbanks were with us. I always feel that we have to call on the women to help us out, and they really did this time.

I want to say too that as far as that Arctic Wildlife Range is concerned, certain Canadian officials are now very much interested to see what we are going to do on our side, and they have in mind making a similar area on the Canadian side. This Arctic Wildlife Range goes right up to the Canadian boundary, and there is a wonderful caribou migration through there. This area, big as it is, does not contain that herd; it comes from the west and crosses this area and goes into Canada, or part of it at least, for the winter. And so the Canadians are thinking of setting up a similar area on their side of the boundary, and I hope that we have the wisdom as a people to set this area aside and show the other nation that we mean business. We will then encourage them to do likewise. They are waiting now to see what we will do on our side, and so many nations around the world are in the same fix as we are. Some of the conservationists throughout the world are trying to set these areas aside, and no matter where it happens, whether it is in Turkey, Scandinavia, New Zealand, or Alaska, it all helps the general program if anyone makes a move in the right direction and encourages someone else to do likewise. That is the case with the Arctic Wildlife Range.

LEONARD: The Quetico-Superior area back in Minnesota and Ontario is an excellent example of the cooperation between Canada and the United States that Olaus was speaking about. There again the Canadian Government has set aside nearly four million acres of roadless area to be dedicated to wilderness values along with the almost equally large area in the Superior National Forest through the roadless area set up by the United States Forest Service on the American side.

PAUL ZINKE (School of Forestry, University of California): I would like to ask Dr. Rausch if in this regard there is any plan to increase the National Forest area in the interior of Alaska, particularly in the Tanana River forests, and possibly to take advantage of the National Forest Wilderness System.

RAUSCH: Just before I came down, I talked to some of the National Forest personnel in Anchorage, and they did not indicate that there would be any increase at all, but they did assume that they would lose little if any of the areas they now hold.

WILLIAM YEOMANS (California Public Outdoor Recreation Plan Committee): This matter of preserving inland lakes from air travel confuses me, as I understand the Quetico-Superior area is now protected by an air barrier. Yet in Alaska, and I have been there a few months myself, this is the only means of reaching these lakes. I would like to know how Dr. Rausch feels there can be a resolution of this conflict, since this is the means of accessibility and yet it can destroy the very quality which you seek to preserve.

Rausch: I think there is probably no very satisfactory solution to that. As you say, it is the only way people can travel in the more remote areas, and perhaps it could only be regulated in areas that are completely closed. Of course there would be a great deal of objection if there were any attempt to do that.

Pauline Dyer: I would like to ask Dr. Rausch if he is acquainted with the present status of the proposed Tracy Arm-Ford's Terror Wilderness Area in the Tongass National Forest. I understand there were hearings two years ago. Do you know where that is and if the Forest Service has any plans for creating wilderness areas on the lands within their jurisdiction?

Rausch: I know where the area is, but according to the latest information I have, there is no particular plan to set aside any of the area there.

Starker Leopold: I want to ask Dr. Rausch about the status of range studies in central and northern Alaska, range studies that is for caribou and reindeer. At the time that Dr. Darling and I were up there eight years ago, it seemed to me that there was a desperate need for understanding the range requirements of these two animals and for comparing the ranges which appeared to us to be over-exploited by the domestic reindeer, with the wilderness ranges which were lightly grazed by the caribou. How far have those range studies progressed?

Rausch: The Fish and Wildlife Service personnel with Dr. Herbert Hansen carried on some rather extensive studies in the Nelchina area; I believe it was the summer before last. But I think that will not be continued, because the Fish and Wildlife Service personnel will no longer have Pitman-Robertson funds available for this work after July 1, 1959. The results of that work I do not think have been published.

Charlotte Mauk (Director, Sierra Club): Ansel Adams, in discussing such conferences as this said: "Yes, they are very fine, but you are just talking to yourselves. What are you going to do about telling other people?" And that has been troubling me for a good many years. As Dr. Rausch was talking, he brought up a problem that we all have recognized and formulated many times. He was talking about the power dam which would interfere with a great deal of the fish life, which has been individually justified, but which still adds up to a considerable damage. Now perhaps we can find ways to convince others outside through the people who learn at these conferences how serious the problem is. Let us reverse this business of justifying small individual parcels of invasion. Big business is developing a sort of pocket morality or dollar ethics. They find that they can take a small part of their income and apply it to public good of one kind or another to improve their public relations and ultimately their business. Can we find ways of persuading the people who would exploit what ought to be unchanged that they can justify the exclusion from their operation of small portions here and there of caribou range—or whatever it may be, down to the surroundings of a small pond on which you will find natural studies worthwhile—can they be persuaded that out of the two operations they may for public benefit justify small exclusions, those small exclusions adding up eventually to something that would be significant to the people who are trying to preserve a natural world?

Leonard: That is being done to a certain extent by some of the larger timber-owning companies in their program of public shooting and park areas, but it is really a fine suggestion to be used by industry all throughout the nation.

IAN McTAGGERT COWAN

Science and the Wilderness

Ian McTaggert Cowan is a man of many provocative interests and many successful activities. His eminence as an ecologist was earned by important studies in the Canadian Rockies involving big game animals and their relationship to such predators as wolves. Presently, his experiments with big game animals are producing much valuable information about nutrition; by means of an artificial high protein diet, he has succeeded in developing certain species of deer to twice their normal size.

The Canadian Research Council profits from Dr. Cowan's membership, and public education has been advanced by his nationally popular television series on natural history. He has also served as President of the Wildlife Society. Originally a Scotsman, Dr. Cowan was trained at the University of California, and is chairman of the Zoölogy Department at the University of British Columbia.

Exploiting his own fascinating experiences and some fine color slides, Dr. Cowan develops his theme: the wilderness scientist is concerned with the ecological environment; wilderness areas must be large enough to provide massed opportunities for the study of natural life. Often we fail to appreciate these opportunities as they present themselves; often we fail to make legislators understand that complete wilderness units are needed. Dr. Cowan illustrates the devastation of wild animals which results from destroying the necessary natural units. Canadian big game provides an exciting and often amusing focus for these ideas.

I DON'T BELIEVE in preaching salvation to the saved, so I am not going to launch into a long diatribe on the tremendous values of the wilderness. We know what they are. All of us here share the common dedication to preserve intact areas of this continent large enough to encompass perpetually examples of the priceless and peculiar ecological entities that are, in fact, North America. They must be large enough to provide the diverse opportunities that the very complex human organism needs if it is to live out its life in the fullness and richness of spirit; they must be large enough also to guarantee the survival of the other large creatures with whom we share this continent.

The National Parks, of course, are in the forefront of our interest, and they themselves, I feel, must now be preserved from overdevelopment as assiduously as they must be protected from neglect. But it is more than this that we strive for in this organization and in our associated groups—it is revolution in the patterns of thought on this continent that we seek, for we on this continent are a very young people. It is only a few years since we landed on either coast of North America and began to hack our way off the beaches into what looked then like a limitless wilderness. We have been nurtured throughout these years on pioneer ideals. We have been taught to glory in the relentless vanquishing of the wilderness by man. I think we can quite safely say that the symbol of our generation is the bulldozer. To our sorrow and concern, it has slowly dawned on us over the last quarter century that the end is in sight. In our militant enthusiasm to throw back the wilderness and open up this continent for man, we have been so far successful that we are about to destroy a part of us that is as indispensable as it is irreplaceable.

To many of us, the wilderness truly unaltered by human interference, the wilderness with its wealth of life rolling across it in great surges, ebbing and flowing with the seasons and with the years, is inseparable from our innermost beings. No matter what our calling, be we scientists or laymen in any line of business, I am sure that many of us—in fact all of us—can join in echoing the words of one of the great thinkers of our time. Mahatma Gandhi said: "I love music and all other art, but I do not attach such value to them as is generally done. I cannot, for example, recognize the values of those arts which require great technical knowledge for their understanding. When I gaze at the star-strewn heavens and at the infinite beauty which confronts my eyes, they mean more to me than all human art can give me. That does not mean that I ignore the other values, but personally, in comparison with the infinite beauty of nature, I feel their unreality too intensely. Life is greater than all art." And it is life, in all its forms on this continent that you and I are interested in.

I find in the wilderness scientist, the scientist who has responded to his calling into the wilderness, the same, or even a greater, feeling of kinship with the environment than was expressed by Gandhi himself. And it is as a scientist that I have come to you this evening, as one concerned for many years with unravelling the mysteries surrounding the biological forces at work in our ecological systems. My major interests have centered on the large mammals—the groups that have suffered more than all others from our alteration of the face of the continent. For some years now, despite the vast uninhabited reaches of the continent, very few first rate studies of the larger creatures have been prosecuted in them.

We have Murie's studies of the elk and coyote in the Yellowstone, Dewey Soper's work on the wood bison in Alberta and in the Northwest territories, Newman's paper on the Roosevelt elk, and Murie's classic and significant account of the wolves in Mount McKinley. These are almost all the best of them, although there are others of more than passing significance. But the contribution of these few to our understanding has been very great.

In general, I have been surprised at how few people have appreciated the unique research opportunities presented by our existing preserved areas. Too much of our wildlife research today is ad hoc and superficial. Too much of our choice of research topics is conditioned by the easy availability of state and Pitman-Robertson funds for management problems. Too frequently have we set a brilliant young mind on to a cow path instead of steering it on to the high trails that lead into the wilderness behind us. To take a brilliant young student with a straight A average and put him to doing some plebeian research task is a wicked waste of a good mind.

To give substance to my comments, I would like to abandon formality for some minutes and to reminisce with you over some of my past research experiences in Canadian wilderness areas. I would show you some scenes which I hope will excite your imaginations, as they have mine, and point in the direction that I think our wilderness research should advance.

I began my studies when little was known of the structure and behavior of wildlife populations, and most of my inquiries were in this direction. Regardless of their present status, they were not old stuff at the time they were discovered, though I don't claim too many first discoveries. The work I am going to report, the reminiscences I am going to pass on, took place largely in the Rocky Mountain Parks of Canada. This is a unique area of 7,000 square miles, made up of four great National Parks with contiguous boundaries. It spreads from shore to shore of this great Rocky Mountain rampart—from the semiarid benchlands of western Alberta over into the great promised land of British Columbia, across the other side of the hill where the dense spruce forests and the great mountains of snow sweep up to the high peaks. I have just a few slides to introduce you to the general features of the environment. We will skip over these quite lightly, because all of you are acquainted with mountains. Many of you may see old friends in the form of mountains that are shown in these pictures.

[*Mount Vanguard*]*

Mount Vanguard, near Thompson Pass, is in the central axis of the Rocky Mountains.

[*Panther River ranges*]

Farther east, as we get out of the main masses and into the eastern foothills, we get a lot of magnificent limestone country with steep slides and spreading grasslands that are the chosen home of the bighorn sheep, and are also invaded from the higher parts by the mountain goat.

[*Panther River ranges*]

Returning to the main masses, we have Crowfoot Glacier and one of the magnificent lakes that is not too far from the Banff-Jasper highway; I believe it is Hector Lake.

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* Slide titles in brackets.

[*Crowfoot Glacier, Banff National Park*]

And this will introduce immediately one of the first problems one tackles in studying the wilderness, and in trying to interpret the forces acting in wilderness wildlife to those who are entering it for the first time—particularly the legislators who find it very difficult when you try to explain that the National Park is not properly designed in the first place and should have included far more winter range.

The majority of the forested area you see there will support nothing but red-backed mice and marten, and very few people see those and enthuse over them when they are in a National Park. There is a little piece of greenery in the middle of the picture which is the summer range of a few elk and moose.

[*Tonquin Valley*]

This is a country of extremes. This photograph was taken on the fourth of September. The day before was a magnificent, clear, sunny day, but this was the first of the heavy snowfalls that covered up this Rocky Mountain playground. That hill in the background is the lower ledge of the Rampart Range, which some of you know. It has been used as a kindergarten by the Alpine Club of Canada for many years. This area again is not much used by wildlife; it is magnificent wilderness that supports wild creatures only in the summer time.

[*Ashnola Valley*]

This is a country of tremendous contrasts, and one of the values that I see more and more in the wilderness—particularly in the reasonably accessible wilderness areas offered by our greater Parks—is its tremendous educational value. I was delighted to hear considerable treatment this morning of the interpretive forces that should be brought to bear on our National Park and wilderness areas. I feel these are extremely important. The great contrast you see here strikes the student who has not before been in the wilderness with an amazing impact he will never forget. The influence of slope and exposure is uncovered.

On our left we have a south and west facing slope; on the far side of the picture we have a north and east facing slope; they have precisely the same precipitation. But one of them is covered in forests of jack pine and spruce, virtually nothing that an animal can feed on; and the other is covered with grassland and provides winter range for two or three hundred bighorns, assorted deer, and even a few stray elk. This sort of thing comes with the graphic impact that will never be forgotten by the student or by anybody who has seen it and had it pointed out to him as his first example. In the northern mountain areas particularly, we are confronted with the wilderness of spruce; and although an eminent ecologist once referred to this as the "Spruce-Moose Biome," he was absolutely wrong. Moose don't eat spruce. In fact, nothing yet has been invented that eats spruce but budworms, a few sawflies, and assorted insects of this sort. Any animal that has the capacity to develop into a spruce-eating ungulate has the world as its oyster: there is an unbroken sea of spruce from Alaska to Labrador waiting for someone to eat it.

[*Athabasca Valley, April*]

This is an area where you can see very strongly illustrated the penalties of overpopulation. To those of you who have worked on range and game problems, the story here is graphically and vividly told. A beautiful clean-swept valley floor and nothing within reach that anything can eat. The branches have been trimmed off the aspen trees as high as a bull elk can reach on his hind legs, and they have even stripped off some of the bark. The willow trees are dead. The grass has been clipped more neatly than you could do yours on a Sunday afternoon. As I say, there is nothing left there to eat, and yet it still looks quite neat and tidy—in fact, I have heard visitors to the Park comment on how neat and tidy the rangers keep the valley floor of the Athabasca River.

[*Athabasca Valley, Devona*]

Some people can learn very quickly to read the story in the wilderness environment. You see clumps of high skirted aspens, again eaten as far back as a bull elk can reach on his hind legs—which is about nine feet when he is enthusiastic. You will notice a dead willow clump; you will notice a few stubs. These stubs are the result of a very effective combined operation. This was a team composed of beavers and elk: the beavers cut them down, the elk ate them off, and by the time they were finished there was just nothing left. The bark the elk hadn't eaten off the trees that the beavers cut down, the beavers chopped up and took for making dams. The only young trees showing there are spruce. This points once again to the ever present hazard posed by the march of the conifer on to these grassland and park land areas. Many of these areas are fire types and if you permanently preserve them from fire, as you can do along a highway or close to a highway, sooner or later you will have the visible areas of our National Parks solid unbroken blanket of spruce and jack pine with nothing in them for anything to eat.

[*Willow ptarmigan*]

All through the park areas, there are multitudes of smaller creatures to be studied; many of them are virtually unknown, if we want to refer to critical scientific studies. The willow ptarmigan reaches its southern limits in Jasper National Park at the precise point at which this cocked willow ptarmigan is sitting. Limits are fascinating things, and for practically no animal in North America can we describe the limits and how and why they act. These are some of the things that can be solved by long continued studies in the wilderness areas where the creatures are not disturbed.

[*Richardson's grouse*]

This Richardson's grouse was photographed in full hoot by the simple technique of walking only when he had his eyes shut in ecstasy, glorying in the noises he was making. This reminded me of North America's advertising. It sounds far better to the people who are writing it than to those who are listening. The Richardson's grouse is widely distributed all through the Rocky Mountain chain, from your own Rocky Mountain areas right through to the

Yukon and parts of Alaska. Here again, though there have been three excellent studies on this bird, we still have a great deal to find out.

[*Hoary marmot*]

The whistling marmot offers some extremely interesting challenges to research, not the least of which are presented by the two isolated southern races looking at each other across the Straits of Juan de Fuca, one of them in the Olympic Peninsula and the other one isolated on Vancouver Island. How did they get there? How are they changed from their congeners on the adjoining mainland, separated from them now by several hundred miles of uninhabited and uninhabitable territory and sharing alike a common uniform color?

[*Porcupine*]

There is an excellent study by Walter P. Taylor on the porcupine. But it is the only one that has been done in North America on the ecology of the porcupine, an important forest wilderness species.

[*Pika*]

The pika, or little chief hare, is abundant in its many races, and one of the species that we now know was separated by the great ice age of North America. It is now reinvading the territory of British Columbia from the north and from the south—separated still by the Skeena River and the Peace River gap, one of the major biological breaks in the faunistics of North America.

[*Beaver*]

The beaver, well known to all residents of this continent, is very incompletely understood despite four or five quite excellent studies made in the eastern United States. In mountainous areas, the biology of the beaver is completely different, and we have to be quite careful I think in interpreting from one area to another. A most interesting example of this was in connection with a study of muskrats I was one time making in the Mackenzie River delta. There is nobody here who doesn't know something about the morals of muskrats: they don't have any. They have as many wives as opportunity offers them and as can be persuaded to cooperate. This is not the case in the Arctic. We found by long continued studies in the Arctic that muskrats there were monogamous. This offers some speculative possibilities that I won't enlarge on here.

[*Mule deer buck*]

We come now to our larger game animals. The mule deer reaches its northernmost limits in British Columbia and penetrates just north of the northern boundary of Alberta. From there it extends south into western Mexico; it extends practically throughout the length of the State of California. Throughout this area, it has specialized into a number of different strains which I will not enumerate, but in the northern part of its area its range becomes spotty. We hear a great deal about animals competing with one another. In point of fact, however, when you look through all the wildlife literature, it is very difficult to point to studies where there was actual realistic competition going on.

But you can find it in these northern wilderness areas, between the groups of big game animals that inhabit these mountains. The mountains were inhabited up to 1927 by moose, mule deer, caribou, sheep, and goats. These animals compete for practically nothing! They can live on the same area, using different parts of it, feeding on different food plants, and getting along very nicely. Then some overenthusiastic park individual brought two carloads of elk from Yellowstone Park, dumped one of them on the valley floor at Banff and the other one on the valley floor at Jasper; the fat was in the fire. Because the elk is a rugged, individualistic, highly social animal that competes with everything in its area, there has been nothing but trouble since then in these Parks. The mule deer, as the one nearest its range limits, has been the first to suffer. We found, for instance, that the mule deer was reacting very differently to the stresses of winter climate and winter competition than were the other large animals on the range. In one very severe winter, the mule deer lost all their fawns, so they came out in the spring with no young added to the herd whatsoever. The elk lost eighty per cent of their young; the moose lost practically none of theirs; the sheep lost about fifty to sixty per cent of theirs. These are completely different reactions to the same climatic circumstances. What was interesting to me was that the carry forward of this experience was completely different in the four different species I have named. The carry-forward in the mule deer took two years to wear down; that is, the fact that the does had been subjected to extreme privations in one winter not only killed off the fawns of one year but interfered with the birth rate of the next. This was not true in any of the other species, which seems to me to point up some of the biological disadvantages that can be impinging themselves on species as they near the limits of their range.

[*Young mule deer in snow*]

In the middle of winter, in those areas where competition with elk is important, the mule deer face a rather devastating situation. Some areas have been heavily overgrazed by elk. There is only one point in which competition does not take place. Elk, in our part of the world, do not eat bear berries (*Arctostaphylos uva-ursi*), whereas mule deer will. But in order to get them, they have to dig down through the snow. The effort expended in getting these nutrients is not sufficiently compensated for. And you have a gradually deteriorating population—practically nothing but spike-antlered bucks and all the other signs that are now the classics of overpopulated areas.

[*Ashnola and browsed Douglas firs*]

The signs are quite easy to read in the spring; mule deer fawns are found dead when the snow melts. On a hill behind, however, 147 head of bighorn sheep passed the winter without a loss, pointing up again the very interesting circumstance of specific food needs or specific food requirements. We don't understand what this involves, but we can see it, or the results of it, quite easily in our wilderness studies.

We found that the opportunities offered by the wilderness areas were extremely important to our studies. That is, you could get close enough to the animals to be working with individuals, and this I want to emphasize as we go on. On these spring ranges, it was interesting to find animals that could scarcely move, that would totter ahead for a few feet and then drop to the ground. When you examined them, their bones had been so decalcified that some skull specimens weighed exactly half of what the skull of a normal mule deer would weigh, as a result of the devastating competition engendered by a large elk population which had been in contact with these mule deer herds.

[*Elk cow and calf in river*]

One of the characteristic habits of the elk in the North (I don't know whether they possess it in the South) is that of taking to the water when they are pursued by any large carnivore, be it a grizzly bear or a wolf. They take their young with them to protect them from attack, a practice frequently just as devastating as leaving them on the bank, because the elk will let these little fellows stand in the water so long that they become chilled, are unable to come out, or if they do come out they die from shock.

Grizzly bears in this area characteristically prey on large game. Another interesting point that came to our attention was the very great difference in the behavior of the bears in Jasper as opposed to Banff Park. There is no explanation I know of, except that the carnivores educate their young. In Jasper Park, virtually all the grizzly bears, and we learned to know many of them by their color, kill big game regularly. In that area there are records of several attacks on people. In Banff Park we have no record of grizzlies killing big game, and so far as I remember there are no records of attacks on men.

In our intensive studies of elk, we found up to ninety per cent pregnancy of the cows in mid-winter; fifty per cent live births pointed to a very large loss during the late spring and during the birth season. Later, only eighteen cows out of every hundred had calf yearlings at their heels, whereas ninety out of every hundred had started out to produce a calf. This gives you some idea of the tremendous depressive forces that are being brought to bear on animals in this type of environment.

Another one of the extremely interesting things we were able to do there was to study the relative proportions of the sexes in populations that had not been disturbed by hunting. We found, for instance, that in these completely undisturbed populations only twenty-eight per cent of the herd consisted of bull elk, that the bull moose outnumbered the cows, that with bighorn sheep the situation was about fifty-fifty, as it was with goats, and that the caribou had about the same proportions as the elk. Mule deer proportions were somewhat indefinite, as the herds were small and the statistics unreliable. So this seems to point to some rather interesting things. The sheep and the goat are promiscuous creatures in their reproduction. The caribou and elk are polygamous herders, or harem builders, and the moose behaves much like our deer. It seems, as far as we can determine at this point, that in the promiscuous creatures the males have a better chance of winter survival than in the polygamous harem builders. There may be a lesson in this; interpret it as you will.

[*Cow elk*]

Disease was one of the most important destructive forces on elk. This jaw of a very old elk cow shows the ravages of actinomycosis, or lump jaw, one of the commonest diseases in the elk. Another was hydatid disease, which was being carried by the wolves of the region.

[*Elk tracks on frozen lakes*]

Aggregations of tracks around small circular areas show competition between elk and muskrats. The muskrats were literally eaten out of house and home, as the elk cleaned up the muskrat houses, and the result was almost a complete freezeout on these particular ponds, almost eliminating the muskrats.

[*Moose calf*]

The calf moose has a very hazardous early life, particularly in this area where the river courses are steep cut, the banks high, and the rivers swift in the spring at the time of birth. We found that drowning was probably the most frequent cause of death to the new-born young of moose. The cows would swim across the river, expecting their calves to follow them up the steep cut banks on the other side, and the poor little devils just couldn't. We watched a number of these tragedies and could not help but feel sympathy for the little fellow as the cow walked off into the woods without a backward glance, as if to say: "Well, if you can't make that you are not very much of a moose anyway!"

[*Moose bull at lick*]

Many of the animals in this area patronize the mineral licks. The moose patronize wet ones, the sheep, goats, and to a degree, the elk patronize the dry licks in the same region. Don't ask me why, as the analysis of the licks is the same. The caribou will be found in either wet licks or dry. Moose patronize these licks more assiduously than any others; in fact they rapidly reach the state frequently attained in beer parlors very late in the evening, a state of what I call hydrostatic equilibrium. I don't need to enlarge on that to the assembled company, nor on the results in the lick.

[*Senile cow moose*]

Here is an ancient cow that has seen better days. She has lost her figure, is a bit sway-backed, a little long in the face. She has a scar of battle that she probably got from the slashing hoofs of another cow. She does not have a calf with her which may or may not be significant. As far as we can determine, and I think this is brought out by all other studies that have been made on this continent, large game animals practically never outlive their breeding years. If they are sterile, it is not due to old age.

[*Bull in Alexandra River*]

The next slide shows a picture of an old bull feeding in the marshland areas they characteristically patronize in the summer time. An interesting opportunity in Banff Park is the result of a mutant pepper-and-salt colored bull moose that now has two or three young cows showing the result of his genes. These animals are now marked, we can follow them, and no one will shoot them.

[*Goat on Athabasca*]

The goats we found to be living on the edge of survival. This didn't seem to be a matter of competition with anything else, nor did it seem to be a matter of predation. So far as we could discover in this area, the goats were competing strictly with the rigors of their environment, and the survival of young was very low.

[*Bighorn on Devona winter range*]

This photograph was taken on the second of January. That time of year is breeding season, and this picture shows a mixed group of bighorns. I have always had the greatest respect for any animal who gets interested in any other animal when it is thirty degrees below zero and a howling wind is blowing out of the west. But that is what the bighorn chooses to do every year, and the results are very satisfactory. The facilities offered by this great park area permitted me to get close enough to determine the sex and age of 3,500 different sheep in two years. This offered opportunities that just cannot be equalled anywhere else, and they are the sort of opportunity that should be capitalized upon more thoroughly by our research biologists.

[*Bighorn ram*]

In the early spring when the range is pretty badly grazed off, the rams are still with the ewes, but almost any day they will separate out and go to their completely separate summer ranges. The land is sometimes forty miles away from the winter ranges on rolling uplands, where they are feeding most of the summer on the dwarf willows that are the dominant vegetation on these alpine meadows. The ewes choose rugged west-facing slopes, where there are little grassy ledges close to easy escape terrain. They demonstrate the completely different reaction of the two sexes to the problems presented by the ever-present coyotes.

[*Two rams—March*]

I am sure most of you cannot see these in enough detail to recognize that the one in front is in the prime of his condition, while the one at the back is very thin and has had a tough time during the winter. I am reminded of a trip I was on once with Jimmy Simpson. On this day we had worked up to some 150 bighorn rams and worked away from each group without disturbing it. Later in the day, as the sun was getting low, we came over a little slope, and there in front of us were two bighorn rams. They were about twenty feet away and lying down with their noses into the wind and their backs towards us. One of them had a tremendous horn on one side and a broken one on the other. I have seen this many times, and have been forced to wonder about the nature of a blow that could sever the horn of one of these creatures. Jimmy looked at me and a twinkle came into his eye. He said: "Let's see how close we can get to those things." So we started to sneak down closer and closer to them; the wind was brisk and the turf was soft. Finally, we were standing not five feet from the sheep and looking down at them. Jimmy, with a glint in his eye, jumped on the back of one of these rams and grabbed him around the neck. Now this old ram, the one with the broken horn, had had a tough winter. And, though this was late August, he hadn't yet shed the winter's fur. So in two great jumps Jimmy Simpson was left pitched on the greensward, completely swathed in sheep hair and looking very sheepish indeed. The ram ran about fifty paces and stopped to look back, as if to say: "What the dickens was that!" Jimmy and I had just finished celebrating his sixty-seventh birthday.

[*Old ram lying down*]

This is one old fellow that I knew for four consecutive years. He was one of a band of twelve, none of which suffered any losses during that time. But this fellow had very bad arthritis in the left front foot, and on the fourth spring he showed up with a very severely abcessed condition of the jaw. He had a bad cough, which indicated to me that he was infected with lung worm, so I put him out of his misery. The lung worm, the foot rot (at least he didn't have that), the actinomycotic infection of the jaw and particularly pasteurellosis are the four main scourges of bighorn sheep in the Rocky Mountains. Pasteurellosis, particularly at the northern limit of the range, just chopped whole herds off. One herd I worked with were 160 head when I left them in October. In November word came to me they were dying, and within the following month we picked up 120 dead ones and the next spring I picked up twenty-five more that had been buried by the snow. That herd was cut back from 160 to about twenty in a matter of six weeks owing to a devastating outbreak of pasteurellosis. The same thing happened in the small group of research animals that I maintain at the University campus. Bighorns are completely incapable of withstanding pasteurellosis.

[*Bighorn ram in summer*]

This old fellow was so fond of salt that he took to coming around our tent quite regularly. One of the most amusing experiences I have had in the Rockies with sheep was my first contact with them. We were fifty miles back from the main auto road in Banff, up Stony Creek. We saw a band of bighorn on the summit. It was early spring and we decided to start the work by a good stalk, see how close we could get to them, and get their age and sex before we disturbed them. So we sneaked and sneaked for nearly an hour and got right up to timberline. The animals were lying on the rocky promontory above us, and we were able to examine most of them. Then with the job done and no other sheep around we stood up to start back down the hill. Immediately upon seeing us the sheep got up out of their beds, ranged in a row on the top of the promontory, and came dashing down the hill towards us as fast as they could. They came right up to us, licked our hands, licked our boots, and we picked ticks off with our hands. On examination, some of the animals revealed that they had spent the summer at Lake Minnewanka Auto Camp. They hadn't seen anybody since October, and boy, were they glad to see us.

[*Timber wolf cub*]

This is the scourge of the wilderness, the timber wolf. This miserable little fellow is chained up with a chain that would hold a grizzly bear. It happened that the hobble chain off my horse was the only thing I had. I got him off a Park warden, who in an outburst of enthusiasm had dug out a wolf den; wolves were supposed to be protected in the Park at that time. He had killed two of the pups, had brought this one back alive for some reason unknown to me, and the fourth pup was a much better digger than the warden and was still going. I took the pup from the warden, put a tag in its ear, carried it back six miles on my way back and released it somewhere close to the den. Everybody thought I was crazy, because the scalp smuggled out of the Park was worth twenty-five dollars. This fellow lived for five years. He found his mother apparently, or at least survived for five years, because I got the tag back twenty-five miles away from where I placed it. It was shot by a trapper just outside of the Park.

Another wolf we tagged was taken 150 miles away three years later. These wolves in the Rockies were moving quite considerable distances. In fact, one of the most interesting studies I was able to make in the Park was made under very different circumstances from that memorable study made by the Muries in Mount McKinley National Park. Although I studied wolves for three years, I saw them only once, but I was able to find out a very great deal about them by some ingenious techniques that are offered to you by the pack organization of wolves and by the different distribution of colors in the pack, so that you can identify the different packs. Also, all the wardens in this area were interconnected by telephones, so that the wardens were seeing the wolves when I wasn't, and we could follow the packs from place to place, chart their ranges, camp on their trails, determine the number of animals they were killing per day, per month, etc., and really learn a great deal about them.

The time we saw the wolves was quite entertaining. I was watching this as I would watch a side show. I was on top of a small mountain, or big hill, watching my assistant working on an adjacent hill. Finally, right opposite him, five wolves came out on a ridge and sat down to have a look at him. He was in behind a big boulder, sitting down having a snack. The wolves howled, and Jim howled back and poked his head up over the rock. Two of the wolves detached themselves from the group; one of them started to worm its way down the slope towards Jim, creeping from boulder to boulder, flat on its belly the way you sometimes see a dog sneaking. The other one simply evaporated. Now I could see the other one, but Jim couldn't. It was coming up behind him. But as the wolf in front got closer and closer, Jim got the feeling of creepiness in the back of his neck I think, because he started glancing over his shoulder. I was watching all this with field glasses from above, and he started to get extremely nervous. Finally, his nervousness broke to the point where he took a shot at the wolf that was sitting like a big dog with his tongue hanging out, looking at the boulder twenty-five yards away. Jim missed it absolutely clean. He told me afterwards that his hands were shaking so much that he could not have hit the broad side of a barn door.

The wolf situation there was intensely interesting. There were approximately thirty-five wolves in the area when I entered it, and when I left it five years later after having killed none, there were still about thirty-five wolves. The old idea that animals go on breeding with the greatest of enthusiasm just doesn't work out. There are all kinds of forces that impinge themselves on such large and relatively safe predators as wolves and grizzly bears. (I marvel that nobody yet has tackled the study of the grizzly bear,* because there is an abundance of opportunities for study in the wilderness areas. It would take somebody with courage, some ingenuity, some tenacity, but it is one of the most fascinating studies still to be made. You would have to be a good hiker. I followed a grizzly bear once for thirty-six miles, and he was still going when I quit. But there are very excellent opportunities.) Following wolves as we were, we found they were killing about one large game animal per month per wolf. Now in a population density of game such as was present in the Park at that time, by the time the winter was over and the new lot of young were being born to the game animals, there were still about 350 head of game per wolf. Of course under these circumstances, the wolf couldn't make the slightest impression upon them, and the wolves were a completely inconsequential part of the environment.

One of the interesting things one learns about predators when he is living in a country where he can watch them and watch the game animals they are preying on, is that the game animals tend to disregard them. Just ten days ago, I was standing on the wharf at Cape San Lucas (Baja California) looking down on a great shoal of Sergeant Major fish. Scattered through the shoal were barracuda—which live on Sergeant Major fish. There was a little ring of respect around each barracuda, a respect that was about three feet wide, but apart from that the fish were completely neglecting the barracudas. Yet as I watched, the barracuda would dart forward six inches and seize one of the fish and eat it. I have seen the same thing in the Rocky Mountains. I have seen a great black timber wolf lope through a band of feeding bighorn. The bighorn would get up from their beds and watch him as he went through, but they are attuned to reading intention by position and action and they knew that the animal wasn't hungry. I have looked down on caribou herds from the air and seen twenty or thirty caribou trotting along the trail followed by four or five wolves, followed by twenty or thirty caribou, then a couple more wolves, all going in the same direction and all perfectly peaceful, until the wolves got hungry. Then they would eat, and then the caribou would go on neglecting them again.

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* Studies of grizzlies that promise fascinating results are being conducted in Yellowstone by Drs. John and Frank Craighead—aided by a tranquillizer (for the bears).—Ed.

Also you learn that the individual with courage, and luck, usually survives even a wolf attack. I remember following the tracks of three or four wolves down the Athabasca River, above the canyon. They were chasing a cow elk. She had gone to bay in one of the little promontories of the canyon, put her back out towards the edge of the canyon, put her head down, and you could just see the tracks in the snow and imagine what had happened. The cow had come to bay. Her ears were back, her hair was up, and her foot was raised. The wolves would not attack. They left her and went on to find something that would not face them. On a similar occasion I followed three wolves, a mother and two cubs, as they jumped a big bull moose. He just lumbered up to the nearest Douglas fir tree, put his back against it and his head down, and they quit him right there. They weren't going to face anything like that, but within 300 yards they killed a yearling elk that ran away. These large very efficient carnivores can kill anything they can catch—anything that will run away from them. I have known them to go two weeks without making a kill, although the area was full of moose and caribou. But there was four feet of snow on the ground, and under those circumstances the wolf has no chance in the world of catching anything to eat. After two weeks of trying they forsook that area and went down the Smoky River to areas of lower snowfall.

[*Hydatid disease in mule deer*]

This is a photograph of the lungs of a blacktail deer, showing hydatid disease infection and cysts. There were twelve cysts in that lung. This is one of the most prevalent parasites in northern British Columbia and one of the reasons why we have been controlling wolves there, even where the damage they are doing is inconsequential. There is little use being made of the game in these areas that are still untouched in the north central part of our province. The wolves were distributing this parasite, which was in turn entering the Indian sled dogs, when they ate the offal of the moose, and then infecting the children and the adults of the Indian population of the central part of the province. We were getting a rather high infestation rate, and in man this is a serious disease because man is long-lived.

[*Two bears*]

Finally, here is the cleanup squad which is so very important in the ecology of the wilderness areas: the black bear. Obviously, neither of these is black, but their mother was. Black bears come in as many colors as human beings, and the white one here is a honey blonde, an albino. It had pink eyes and light claws, etc. The bears are very sensitive to certain environmental circumstances we don't yet understand. We have had very serious food conditions for bears in some years, when there was a complete berry crop failure in the Rockies. These are the years when you have trouble in the villages, and in which apparently many of the bears die during hibernation, or shortly after hibernation. But there is considerable thinning out of the bears during years of very poor crops or complete berry crop failure. Then a couple of years after that you are apt to find very large litters. In one year we had three litters of four in the black bears of this Park area. That was two years after a berry crop failure. These are observations that are largely unsupported as yet, because the studies have not been prosecuted to the point where they mean anything. But it is these observations that start you on the route to examining things that may lead to truths of some importance.

As I mentioned earlier, the major part of the studies we have already completed concern themselves with forces that build, confine, or destroy populations. There is still a great deal to be learned in these areas, the areas of population study, but I have been increasingly impressed with the need to study the individual. This is as true when we study them in the lab as when we study them in the wild, because the population is constructed of individuals. Not until we understand the individual will we understand what is happening to the population. We have learned a great deal by applying statistics and actuarial methods and techniques to the study of wild game, but we have also hidden a great deal. We have applied our statistics in the wrong places. We are convinced now that it is better not to apply the statistics until the final denominator on the individual is reached.

Here, even more than with population studies, the dedicated wilderness areas are essential to the progress of research and to the solution of the problems that face us, because only here can you mark your individual with reasonable assurance that the interference of man is not going to remove it before you learn very much from it. It is highly important, therefore, that this aspect of wilderness be considered in detail, as existing reserve areas are reviewed and as additional ones are established, as they will certainly be in the northern parts of this continent, and as they are being at the moment in the Yukon, in the Mackenzie Arctic, and in the eastern Arctic of Canada. The wilderness contributes to science not only unique opportunities for research but the constant revitalizing stimulus of contact with the mysterious. And lest I be called unscientific in suggesting that the mysterious is worthy, may I end my talk to you with a quotation from no less a person than Albert Einstein?

> The most beautiful thing that one can experience is the mysterious. It is the basis of all true art and true science. He to whom this reaction is a stranger, who can no longer pause, wrapped in awe, is as good as dead, for his eyes are closed.

RAYMOND B. COWLES

Population Pressure and Natural Resources

A prominent ecologist, Dr. Cowles recently returned to South Africa, the land of his birth, to observe ecological phenomena, including the impact of man on the African wilderness. His findings have been published in the unique book *Zulu Journal*, by the University of California Press.

World population pressures are dramatically likened to skin cancer: the cancerous multiplication of human beings threatens wild animal life, the forest, and even the very soil upon which man himself depends. This progressive disease cannot be arrested by palliative measures; the immediate establishment of wildlife preserves and wilderness areas, while by no means to be abandoned, will not in itself guarantee conservation. To save the biotic world—including man—we must emulate the physician, who in treating cancer seeks to control random and excessive multiplication of cells.

BEHIND EVERYTHING that I am going to say is the Malthusian principle: the principle, expressed 150 or 200 years ago, that man has the capacity to outgrow his resources by continued multiplication until some limiting factor stops reproduction, and he comes into equilibrium with his environment. Malthus painted a very gloomy picture, which fortunately did not come true, and it has been customary to discredit Malthus's views because his timing was wrong. But there are a great many people today who are looking with considerable concern at the inroads on our resources, including, of course, inroads on our wilderness areas and sanctuaries.

These people fear, and with good reason, that we may realize the Malthusian principle by destroying and exhausting our resources and thus disenabling ourselves to realize the standard of living which has been the objective of our country, and the world, since time began. I am more optimistic; we may still have time to develop maximum efficiency in the utilization of our resources toward the greatest good for a reasonable number. If we have time to learn the lesson, then of course our worries are needless. But there is the danger that we will not look far enough ahead to allow ourselves the time and the opportunity to avoid some obvious pitfalls.

Many demographers and some economists, for example, have been crying "wolf" about our petroleum supply. Ever since I can remember, petroleum has been about to run out. Presently, petroleum in its available form is in sufficient supply to last for about fifteen years of peak production. Then it will rapidly fall off. I think, with respect to petroleum, that we may have some latitude; but we must be very careful, because ninety-five per cent of our agriculture, our food supply, depends upon power supplied by petroleum.

Because of the well-known population explosion our natural resources are dwindling as measured on a per capita basis. However large a given resource may be, double the population and the per capita share is automatically halved. For resources that are in limited supply, halving them makes them wholly unequal to the demand. For finite resources, such as oil, ores, and coal, this doubling effect will get us to the bottom of the barrel in a proportionately short time. Time, during which we can discover and substitute other things (the hydrogen reaction as a source of energy, for instance) may be so shortened that substitutes cannot be made available—if they exist. The longer we delay the recognition of this fact, the longer it will be before we bring our own ecology into the same sort of balance that we insist upon in nature and in farming.

This is just one of the things that concern these people and which give rise to the Paley Report on resource depletion and the need for stock piling. Ours has gone from a nation exporting raw materials to one into which we import ever greater quantities. We have expended our own resources to obtain wealth from the world around—with which we exploit our country.

Yesterday, we heard a recital of some of the dangers that beset wilderness areas, wildlife resources, and resources for scientific study. I might just run over them. The East Coast of the United States is now subdivided from the Canadian boundary south—from the middle of Maine clear through to the tip of the Florida peninsula. This long line of once "unlimited" coast is now completely occupied. Our marine littoral in Southern California has virtually disappeared. We heard how the coral reefs have been stripped. We heard that the salt marshes on our Southern California coast have virtually disappeared. All of these things have not been used up—in a sense—but our population has increased to the point where it is using all these resources currently. There isn't room enough for the people who would like to live on the beach to get to the beach and own property there. As our numbers increase, so will the pressure on this resource. We cannot destroy a shoreline or a waterside habitat—we cannot destroy the actual length and breadth of it—but we can use it and deprive others of its use, which means that the pressure of competition for this limited resource rises. This will be true of all our resources.

Last summer, on a hot week end in Los Angeles, everyone went to the beach. The lifeguards made a census of the number of people who were on the beach on that day. The census was published (you know Los Angeles, everything bigger and better); this was fine: a big crowd. But I took the trouble to figure the mileage from the Mexican boundary to the Ventura County line and subtracted Camp Pendleton, the Marine Base, from this and came up with the fact that the people who were on the beach that one day, had they spread out evenly between the Mexican boundary and the Ventura County line, would have had only two and one-half linear feet of beach apiece. Now if we double our population as we hope to (in fact, our ambitious Chamber of Commerce in Los Angeles would like to quadruple our population for some reason) this will reduce the linear space on the beaches, and on all waterside resorts, until we will have standing room and nothing more.

This indicates the subtle corrosion of our standard of living: less and less pleasure, fewer and fewer of the amenities of life, as we get more and more crowded. Someone is always jostling our elbows. On the freeway, it might be more than a jostled elbow. We cannot keep ahead of the race for more and more people, with the greater and greater resources they require. In fact, changing Malthus a bit, I would say that today probably our greatest immediate danger is that we will grow too fast to be able to keep up with our own growth, just as with the highways: one is barely finished, and it is so overcrowded that another must be begun. This is a limitless, endless, process. And we, as organisms, have the capacity to continue reproducing in this fashion—and there is no known antidote to this continual reproduction—until we will resemble China, India, and other such countries. Already, I personally feel, the amenities of life are dwindling away rather rapidly because of overcrowding. Even in the Sierra, and in other remote places, it is not infrequent that you may have to stand beside a trail for half an hour, waiting for a crowd of travelers to pass. I know of one instance where a man waited for an hour and a half for one group of Sierra Club members to pass him on the trail. They are the best of all people, but too many people at one time in one place rather detract from the feeling that an area is a wilderness.

Well, these things are implicit in the minds of all. I wanted to go over them briefly, because I am taking the vignette approach to what I have to say today; these little excerpts by themselves may appear isolated, but they will intertwine and give meaning, I hope, when I reach the end of the presentation. I should also say that when I lecture on resources to my class at UCLA, I devote not less than seven fifty-minute lectures to the material I am trying to cover here in less than fifty minutes. You see, I will have to use this sketchy vignette type of approach and allow you and your knowledge to integrate these things into a coherent whole.

Every time I travel up and down our coast or eastward to the Atlantic, I am amazed anew at the still limitless expanses of unoccupied lands, and I wonder once again at the foresight of those who have already worked to set aside our National Parks and our wilderness areas. I feel much the same when I fly over Africa and view its unused wild lands, and again I feel the resources of the world are limitless and that our space troubles are interplanetary rather than global. Yet, when we look closer at this picture and see the square miles of closely bordering farmlands wherever farming is possible, and when the country's good acreage is given over either to farming, or to residences, or to tier on tier of apartment houses, streets, highways, and airports, I think we obtain a glimpse into the future. Most of our citizens, especially the younger ones, have no concept of the rate at which wild lands—or all lands—are being utilized today. Just recently I commented to a medical friend of mine that if his fraternity continued to encourage reproduction and so successfully to reduce the death rate, we would soon be in trouble for lack of food. His reaction was angry—and personal—and he asked if I had ever seen our unending supply of farmlands stretching eastward from the mountains of Southern California to the plains of Kansas. When I protested that lack of water might prevent the use of these lands for farming, he replied that when we needed water we would get it. That intervening land, in case some of you haven't been over it, is the Southern California, Arizona, and Utah desert—clear over the Rockies and eastward until you reach genuine agricultural country, where rainfall is greater than fifteen inches per year.

The widespread lack of perception of our inroads against nature comes from such thinking as that of the medic; but it is even more largely a result of the fact that the environmental changes during a year, or even several years, are like the evidence of human decay: almost imperceptible to those who have never left their aging friends. Change is creeping, but it is remorseless, and since man in numbers is the cause of these changes in our wildlife and our lands, and since he will apparently increase his numbers to maximum levels, the rate of his occupation and use of resources will increase correspondingly or at a greater rate.

For instance, this Conference would never have been thought of one hundred years ago. At that time, nobody could ever have dreamed that there would be a shortage of wildlife, lands, and forests.

It was from widely spaced visits to Africa that I learned to see the clues to an alarming future, in which man's needs and his numbers will increasingly jeopardize the wilderness and himself. From this came, first, a glance back at the United States, then a searching study to see if there could be a parallel between our country and what I had seen in advanced stages in the native reserves, where Malthus's predictions are coming true. What I saw as I looked over my shoulder, so to speak, from the land of natives to the United States and our wealth here, was a sort of specter, because there was the example of how things might go wrong with the United States unless we use our scientific knowledge.

Because of the comparatively long intervals between my visits to the wild lands of Natal and Zululand, the cumulative changes became starkly apparent. But if in one man's lifetime, the wildlife of an area as large and diversified as the Union of South Africa can suffer such contraction as it has, what of the changes in our children's and our grandchildren's lifetimes? I can only say that because the damage has resulted from growing numbers of human beings, and because they will undoubtedly increase by total numbers amounting to two or four times the increase through my lifetime, my children, in the broad sense, or certainly their children, may be forced to destroy out of their needs and popular demand, many of the things that we here hope to preserve during these days of setting aside and protecting the wilderness. Several decades ago South Africa found it necessary to develop game laws, forestry laws, and even laws against picking wildflowers—this in a remote African continent, which we think of as underpopulated and so spacious. Laws to prevent the picking of wildflowers! That seemed to me to be the epitome of the changes that have occurred in that continent in so short a time. These are all due to rising pressure on resources which threatens preservation of nature.

It seems incredible that the Dark Continent, that remote and richly endowed part of the globe, could be giving us lessons on the needs and difficulties of preserving nature and a unique fauna. To the inexperienced on that continent, there may appear to be no danger. To the old timer, the signs are everywhere, but they are most notable in the Union of South Africa. In fact, South Africa is a field station ideally arranged for the study of human ecology and on a more comprehensible scale than in our country, which is so large and complex. It also has the additional value of providing us with an experiment on competition between nearly identical subspecies of an organism for their survival. This is the Black versus the White. Unfortunately, the purely human emotional overtones are there. Competition has led to fear, distrust, and hatred. I am fairly certain that the inevitable biological solution is war between the subspecies and survival of the more desirable of the two—survival in the broad sense. Certainly the danger hangs ominously over the entire country. Here again, I would like to interpolate a comment: the war that is being fought there now might not be properly called a cold war because it is a war of the cradle. Consciously the "Whites," unconsciously the "Blacks" and the mixtures, are having a race to see who outpopulates the other; and this in a country which is precarious, as you will see, with respect to natural resources. It is war by the cradle. Cold war, hot war? Probably hot war!

I am convinced that preservation of South Africa's wildlife and wilderness areas, at any time beyond the next generation, can continue only so long as there is White domination. The revolt may come within a decade, or within a few decades, and the Whites can maintain their domination only so long as they can provide a tolerable living standard for the Blacks. There is insufficient time in which to indoctrinate and to educate the Blacks so that they will look at the fauna and flora as valuable resources, in terms of esthetics and science, rather than in terms of meat. The African name for wild animal is ny-ah-ma; that is also the word for meat. They speak of their wildlife as meat rather than, as we do, of the various species. How long a time we have depends upon a number of factors, but in terms of continued population growth, it will almost certainly be less than another generation. (I'm speaking of South Africa here.) Our children may, and our grandchildren almost certainly will, read of the disappearance of most of the wildlife in the southeastern part of the African continent. It is very difficult to conceive of a hard-pressed people, with a history of warfare and hunting behind them, submitting peacefully to the continued regimentation and domination by Whites, while they themselves are suffering actual protein want, and a protein want that is becoming ever more acute.

Over many successive bad years, the drought years, maize and wheat even now must be imported into South Africa. This importation is made possible only because of the country's enormous mineral wealth and its rapidly increasing manufacturing activities. But is it wise to rely solely upon the mining industry to supply food, imported from abroad, to a turbulent people who are already on the verge of starvation, and who are becoming serfs to industry, in a sense?

Apparently the Union of South Africa feels no concern as to the possibility of continually feeding its people by this means. This is because of the country's vast metallurgical resources, its cheap labor, and its moderate amount of coal. But unfortunately, with an enormous store of fissionable material, it expects to supplement the domestic food shortages of inadequate local production by trading the products of its industries for surplus foods from "elsewhere." I asked the officials who are planning to put all their faith on export of raw materials and industrial products where this surplus existed elsewhere. They said, "All over the world." I asked them, "Could you be more specific?" and they said, "Yes, the United States will supply it in exchange for our products." They are thinking of eventually exporting cars to this country. They must succeed in this plan to support their people; the plan simply must not fail, for if the government fails to feed its people by this means, only the government will be blamed, and government, to black people, means the Whites.

As part of these precarious plans, we in the United States come into the picture. At the present time we are the only country in the world that produces massive surpluses, and some of our farmers look forward to only a decade hence, when we will consume all that we can produce. But what then of South Africa and all the other industrializing nations? For that matter, from where (other than Canada) will we get basic foods when we have subnormal crop years, as we do recurrently? That is, when we are eating all of our surpluses each year, and then we run into bad years, from where will we get our surpluses?

When we consume all our produce in the good years, and when our population will presumably double in fifty to sixty years (this is the latest demographic figure), what will be our descendants' attitude toward wild lands that are capable of producing food here in our back yard?

Please withhold judgment, while I go through some material that is rather hard to swallow, but which I hope to make more palatable later.

There are many puzzling questions as to the probable success of industrialization for feeding a steadily rising population in any land or nation. So far, however, it is not our problem (or so it is said) except that backward people, impoverished people, or wealthier people with a steadily diminishing supply of food (or steadily rising food prices due to lack of surpluses) are apt to become restive. This is particularly acute to us today, because we are having to win the friendship of the so-called backward people, or the underdeveloped countries, throughout the world. (There was an article this morning in the newspapers about the necessity of our supplying them with capital, food, and the means to a livelihood. This, I think, is of great concern to us.) I am thinking of Asia and Africa, mainly—when I say that people are becoming restive—and of Latin America. I think it is entirely reasonable to ask questions, even for the United States with its great wilderness areas, because our annual population increase is already four and one-half millions per year. That was our last year's crop of children—four and one-half millions. Unless we know how to hold our wilderness areas against the rising needs of an increasing abundance of humanity there does not appear to be much point in establishing them, since they are ultimately to be ravaged by would-be exploiters supported by a self-interested and unappreciative, or unwise, public.

We are accustomed to thinking of our wilderness areas and wildlife preserves in terms of "all time"; in fact, the words "in perpetuity" have been frequently used in these meetings. This idea is frequently associated with their establishment—always, I think, with the establishment of wilderness areas.

When speaking in this manner, I presume that by "in perpetuity" we mean not less than three generations beyond the present one. Because of the unpredictable effects of population explosions, both here and throughout the world (and the world's annual new crop of some *forty-eight million* more mouths to feed) we cannot logically expect sentiments regarding wilderness areas to remain forever precisely as ours. If future pressures for resources can change, then we must look forward to and plan for long-term strategies that will prolong and make them "perpetual," if that is possible.

For example, if now and then we fail to keep inviolate our present wilderness areas at our present population, can we expect them to be enjoyed by our great-grandchildren? There are already successful inroads into wilderness areas and into our wildlife resources; if we can't prevent them now, what will the condition be when the pressures for these resources—even if only for space—are much greater than at the prseent time? It seems to me that we should be forced to reëxamine the basic premise of our problems, to see wherein we might be overlooking the effects of numbers multiplied by time. I think there is a simple answer, but that we will use it I doubt. If you don't agree with what I have said already about my perturbation over diminishing supplies and areas with rising populations, then your doubt of the statements is the reason for my belief that we may well fail to take the necessary steps in time to preserve our lands.

This month the United Nations demographers have stated that the world's population has passed the three billion mark. At this rate, the next generation will exceed six billion and the subsequent one twelve billion. You see, this is not a static thing. We don't come to a level and then maintain that level. We are always increasing the population.

At present reproductive rates and death rates— *if* these two hold as they are —this means that before our great-grandchildren grow up, each year's crop of children (and they are already a surplus for more than fifty per cent of the world) would be sufficient to more than replace the entire present population of the United States, which is approximately 170 million, every year. If this goes on for three more generations, then every year the surplus children of the world would entirely repopulate the United States, up to its present level.

Although the establishment of wilderness areas and all other types of wildlife preserves, and the consequent running battles to retain them, are now an obvious necessity, I am afraid that over the next few decades we will discover that this type of activity, alone and by itself, cannot withstand the coming flash-flood of humanity and the pressures that accompany it, and that we will find it difficult to preserve for our *great*-grandchildren the benefits that we envision for them. We, the United States (and the rest of the world), are threatened by an ecological sickness that resembles not a static condition of organic ill health but a progressive illness. Palliative measures cannot arrest such a disease; only the treatment of the underlying causes can do so.

Although the analogy of skin cancer has been used by others in order to picture our ecological ills, the analogy so vividly illustrates the prospects for preserving the wilderness that it should be expounded again and again.

To explain: little more than a hundred years ago the reasons for this conference would have been unimaginable. To use the cancer analogy, at that time the living world's innate defenses against a threatening imbalance of self-reproducing units (that is, human beings) had been at work in the form of viruses, bacteria, and starvation to curb the growth of population. These forces worked automatically, and nature was ruthlessly successful in preventing the development of a pathological condition—that is, overpopulation—on the world's biotic surface. However, collectively these cells (or human beings) have become relatively free from the balancing forces of death and at an accelerating rate they have increasingly multiplied and invaded hitherto uninvolved tissues (that is, areas of the world), especially those remaining healthy (such as wilderness areas). If cancer cells go unchecked in their multiplication, they will kill the body that supports them. If man reproduces unchecked, what consequences will there be to the remaining small bits of uninfected land, the islands, the wilderness areas, the sanctuaries, the parks, and so on? Orange groves are disappearing from Los Angeles County and from adjacent counties. What remain are just little patches and they are only temporary. The cancer is even now spreading below the surface of the Earth in the form of mining and other extraction industries so vital to survival of the human biota. What will happen to the host itself, to our entire biosphere? The human population has virtually enveloped all the good earth. We have a layer of humanity, or of human activities, that now covers all the globe excepting the poles—the Arctic, the Antarctic, and the mountaintops. And even there, wandering cells are penetrating, drifting, and looking for more resources.

I need not pursue this analogy of growth and the spreading metastases of skin cancer. We can see the analogy in the multiplying human beings, and we see its effects when we fly over our land and when we view the communities that are strung along our highways. Personally, I think that Southern California offers a particularly apt example of the spread of these metastasizing units along the vascular network of our highways, setting up ever new colonies. These new colonies are followed by the discovery of new pathways to ever more favorable and more beautiful areas. We already see an unending multiplying and remultiplying effect, until man virtually will have destroyed the life-giving layer on which agriculture and his own welfare depend.

There is no innate self-limiting factor discernible, and apparently, once it gets beyond control, the only cure for either genuine skin cancer or its analogy is the death of the host as well as of the causative cells. Is it possible that the analogy can be carried forward to prophesy the inevitable conclusion for man as a spreading and metastasizing agent? Long before death overtakes the victim of cancer from the wild, uncontrolled, and irrational multiplication of lethal cells, this type of illness becomes increasingly apparent through a succession of mounting symptoms, at first minor, but uncomfortable. Only through the early recognition of these symptoms, and drastic treatment, can there be hope for preventing ultimate death of the whole organism.

Here we end the use of this vivid analogy; it is an ugly one, which I hope may help to clarify and portray the effects of uncontrolled human multiplication.

On a more optimistic note, I believe that new developments—tracer element research in agriculture, radiation and mutation, economical large-scale processing of oil sands and shales, and use of atomic energy for metal mining—may combine to again postpone for at least a short time the food and shelter predictions of Malthus. But this new hope should provide no assurance to proponents of wilderness areas or sanctuaries for wildlife. We will become even more densely populated if we can extend the use of these finite materials for a time, and then our plight will become even more desperate.

I think too many of us are prone to believe that man can forever solve the problem of his subsistence, irrespective of his numbers, and that somehow preservation of wildlife areas and wilderness can be continued hand in hand with this increase, without at the same time making any effort to achieve the ecologically necessary balance between human populations and the amounts of living space and resources. My own opinion is that it cannot be done, and that what we are seeing is a premonitory, incipient expression of the Malthusian principle that is causing stresses in preservation of the wildlife resources and so on at the present time. Our grandparents could never have envisioned our present dilemmas with respect to wildlife and the wild lands.

Evidence for this assertion can be found in several kinds of human reactions. A seemingly trivial local example is the steadily rising cost of waterfront property, wherever it may be: beaches, streams, or lakefronts. The amount of linear footage is still the same as it ever was, but the pressure is increasing immeasurably. The capacity to overwhelm beauty in nature is innate in excessive numbers of any animal, and man is no exception to this rule. We are ecologically out of balance with our world already.

The demand for invasion of wilderness-sanctuary areas for water storage and power dams, oil rights, iron ore, irrigation, forests, farm lands, and so on is now but a gentle movement in comparison to what it will be with our predicted population of even forty years hence (which presumably will be two times our present one, or 340 million, to be fed with these resources that we have). I suspect that nothing having potentiality for satisfying the necessities, in the broad sense, can even briefly survive this kind of developing hunger.

It is not difficult to multiply examples: you have the pressures for lake fronts, stream sides, beach frontage, mountain property, anywhere there is beauty. These resources are as ample as they ever were, but not in terms of our present population size. You see, underlying everything is our population size, again and again. *This is the basic factor.* It isn't that we have used up or consumed some of these things, but that we have simply outgrown them in terms of numbers relative to available areas.

With continually mounting populations, by their sheer numbers, the pressure for property and the prices for natural scenic property anywhere can be expected to parallel the developments in waterfront property. As I see it, the stages that accompany population-density growth will take approximately the following insidious steps: First, we see the need for wilderness areas; for their beauty, their peace, their scientific value. We restrict the wilderness areas to foot travel or to horse travelers, but their numbers will increase along the trails until one is never out of sight or sound of others. Then there will be more trails added in order to dilute the density of the hikers on the trails; and we will probably have pack burros and horses increasingly to get to more remote areas and allow people to escape to the very thing for which wildlife and wilderness areas were established—solitude. So we will crowd, then develop more trails in more and more remote areas. Following this, there will be pressure for access roads—for fire protection, chiefly, or for those that don't have the hardihood to do it on their own feet or on horseback to traverse and merely see unspoiled nature. Then there will be requests for fixed campsites to localize the damage from an excess of people in the area. Then there will be demands for other campsites within the area so that more people can linger and enjoy the wilderness. A store, then stores, to supply food for more campers. I think most of you follow me; this is supposed to be a prediction, but I've seen it happening already. These stores will spread through the area to supply more food for more campers. Then we will see demands rising for the establishment of inns, as they will be called, but they will be hotels, and then more of these inns or hotels, in order to supply comfort for the people who are not rugged enough to take the wilderness by themselves. Then there will be demand for amusements associated with these inns and resting places to beguile the people who are bored during the hours of evening and night when they can't see anything. This will be repeated and there will be an insidious multiplication of these types of accommodations to take care of ever more people. And there will be more roads to give more fire protection, more accommodations, and to dilute the harmful effects of local pressures we will have a spreading web of roads, until there is no genuine wilderness left. Then there will be frank conversion of these accommodations to resort use. Ultimately—because we no longer have a wilderness—subdivision could logically follow. Who cares beyond that?

If it is doubted that increasing populations will demand almost precisely these steps and in the order given above, we may merely look around at our most popular National Parks and witness these stages of this evolution, and the struggles, as those who wish amusements enter the Parks. The same situation prevails around the world, for human nature is much the same everywhere. I was amazed to run into traffic jams en route to the Kruger National Park, where you see wild elephants and lions, and to encounter insufficient accommodations for tourists. They are going to build more camps. And that's in the heart of the Dark Continent!

Finally, with the population of the United States now increasing at somewhat less than four and one-half million per year (and with the rate increasing with each crop) pressure cannot remain constant. Simply to allow each of these new persons one acre of space and solitude for a simultaneous summer holiday would already require the addition of 7,031 square miles of park or wilderness *each year,* just to accommodate our annual new crop of potential visitors. So all I could think of yesterday, when we were hearing of the resources of Alaska, was that we will have to go to Alaska to get these 7,031 additional square miles per year of land set aside for wilderness areas and parks.

I do not believe that any wilderness or nature park can proffer much hope for long-range success, unless plans for its perpetuation include in equal (and probably in even larger) measure successful campaigns for population limitation. It seems to me that it is folly to ignore the human ecology. In the study of that of other animals, in our plans for saving the primeval wilderness, or even for saving many fragments in the form of National or State Parks, we cannot succeed unless we can stem the multiplication of our population within the very near future. There is already grave doubt as to how long, even with the population stabilized at present levels, we can persist without destroying our resources and our security. If we are to save the patient—the biotic world including man—our only hope would appear to be emulation of the physicians and learning how to stop the multiplication of these randomly, wildly, multiplying cells.

DISCUSSION

STARKER LEOPOLD, *Discussion Leader*

LEOPOLD: I think we can see that protecting wilderness is only one facet of this much larger problem of protecting the ecological security of the human race. I may say that there are probably few people who have been more favorably situated to observe the ills—or horrors, if you will—of overpopulation than Professor Cowles, who has divided his life between South Africa and Southern California. Certainly Dr. Cowles has brought this difficult problem to our attention in a way that makes it hard to ignore.

Before opening the problem to general discussion, I would like to amplify one or two of the ideas just a little. As a biologist, I don't believe that any population can go on increasing indefinitely. Therefore, I would envision the end product of increasing human populations in a different way than Professor Cowles. Understand that I am basically a complete believer in the Malthusian concept of population. Now what will happen to the human race if we do not control population growth?

I think the sequence will be as follows. As we use up resources, the technologists will find substitutes for us, or so we are told. In finding substitutes for cheap resources, prices go up: the cost of supplying power, the cost of supplying any other resource that we need, will rise. As costs rise, living standards will drop. I think that this may be a slow steady process of attrition in living standards rather than a complete explosion and collapse of the sort that Dr. Cowles has indicated, and I may say that he has some excellent company, William Vogt and others, who can envision as a terminal process a major catastrophe. Nevertheless, I am almost more worried by the slow and gradual attrition in living standards toward a state where life for the human race may not be worth living.

In this process, however, I do *not* agree with Professor Cowles's point that the dedicated recreation areas are necessarily going to be gobbled up by the necessity for providing physical resources on which to live. I think, rather, that this is a matter of establishing locally in each population a tradition of maintaining parks, wilderness, and wildlife areas. And, as evidence of this, I would point to the fact that the greatest cities of the world have parks. In the middle of New York is Central Park. The value of that land is perfectly astronomical as real estate, yet the idea of turning Central Park into real estate would be abhorrent to everyone in New York. However low living standards might fall, I don't think that that is the way it will happen. There are other examples: in Japan, and in many other areas that are overpopulated in relation to their resource levels, parks (and in the case of Britain, even wilderness areas) are now being established and developed. They are not being absorbed to meet physical requirements. Therefore, these are details on which I am taking issue with Professor Cowles. I am envisioning a slightly different terminal process to the overpopulation problem. But, unless it is solved, it will most certainly lead to distasteful end results in terms of living standards and individual happiness.

RICHARD LEONARD (Berkeley): I agree thoroughly with Starker. In fact, I was going to say much the same thing. I am completely convinced of the validity of the Malthusian law of population growth, and I agree that it is a tragic problem that we definitely should pay more attention to as conservationists. I do think, however, that if I felt that the wilderness were going to disappear in a few generations, I would not be willing to expend the really immense amount of effort that is necessary to save it, merely as a delaying action. I think one of the greatest encouragements is the action of the people of New York State. In 1890, they wrote into their Constitution that their forest lands should remain "forever wild." There have been many attempts since then to try to break that down. In 1953 the Wilderness Council met in the Adirondacks because of the coming vote on that problem. And, through the leadership of George Marshall, Zahniser, and many other people in the New York area, the vote was *three to one,* in spite of tremendous population pressure, to keep that land "forever wild." This illustrates a tendency, as Starker has indicated, that the wilderness becomes more and more precious as there is less and less of it. The battles will become increasingly severe, and we may lose considerable portions here and there. But some of the finest of it is going to be kept just because of the fact that wilderness is a part of the standard of living that we are desperately going to try to maintain—at least, as Professor Cowles says, until we are overwhelmed by our own inability to think the thing out in time. It is the thinking ahead that we have to work out, so that we won't have to make this tragic choice at the end.

Professor Stanley Cain: Professor Cowles did not say that we would lose our wilderness areas and our National Parks as boundaries on the *land*. What he said was that we would lose it as wilderness. It would be occupied progressively by a lot of things which destroy it, in effect, as wilderness. Central Park and Golden Gate Park are municipal examples: they are filled with academies of science, academies of art, skating rinks, and what have you.

James Roof (University of California, School of Forestry): I am interested in the overcrowding of Southern California. Working there as a field survey crew member, I saw a great deal of wilderness and very few people. The usage is small and concentrated at certain waterfronts and other kinds of area and does not seem to be so devastating.

Professor Cowles: That is perfectly true. But I have been in Southern California since 1916 and have fished most of the streams and wandered through most of the mountains and the change is peripheral. It is working in, up all the streams, up all the occupiable places. Here is where the density is increasing. This is imperceptible to a person who hasn't lived there and perceived the changes slowly taking place. In South Africa, when I spoke of my concern, the residents said: "Nonsense! Look at all the wild areas we have." That was true enough, but I have seen the subtraction in my lifetime of thousands and thousands of square miles which have been denuded. It takes time, a long interval of time, to appreciate these changes. It is like aging in a person—you don't see it unless you've been around a long time. I like the optimistic view, but I just cannot go along with it.

John DeWitt (University of California): I think it is of paramount importance that we recognize now the danger of continued population growth throughout the world, and I would like to support Dr. Cowles's view very strongly. Wilderness merely indicates a greater pressure on our whole natural-resource base; the economies of this nation and of the world are at stake, as is our standard of living for the future. This is something we must all recognize now, and we must take action soon to face this, if we are to survive as a species, and if we are to have the kind of world in which we want to live.

There is another point, though, that has not been made here, that I think is extremely important: freedom cannot exist generally in the world unless you have a resource base that relatively allows expansion of population. As soon as limiting factors take over, as soon as the population is limited, freedom is limited—freedom of the individual. We are seeing it today in America; it is coming very fast. We don't have the freedom that our ancestors had. There isn't the free land. Little by little, institutions are encroaching on our individual liberty to the extent that it will not be at all the same in another one hundred years as it is now—and this even in a democracy. This is related closely to our resources—much more closely than any of us realize. Many of the causes of war, also, are related to this.

Starker Leopold: I agree with most of that, but let me debate one point. I don't think that an economy has to be expanding to be healthy. As embarrassing examples, I point to Switzerland and Sweden, two countries that have stabilized populations and whose living standards are high and whose degree of freedom, I think, is certainly as great as ours—freedom of the individual. So that as expansion can no longer proceed, we needn't be hopeless about the living standards of freedom of individuals. This is to me one of the heartening things: that there are places in the world where population is balanced and living standards are held at a high level. Likewise, I found heartening the fact that the American public is highly sensitized, apparently, to slight shifts in economic conditions; the rate of birth, in the recent recession, dropped very sharply—not enough to change the over-all statistical trend greatly, but there was a marked drop in the number of children conceived during that short period. In other words, as lowering living standards, meaning lowered economic conditions, begin to come to bear on an educated and advanced populace such as ours, there will be an automatic tendency toward balance. This I find heartening, though it may not be enough.

Professor Cowles: With regard to that, we saw it in 1929 and 1930, which many of you don't remember—this drop in the birth rate, due to changing economic conditions. However, we must remember the people who are born just before such a recession; they are doomed to live out seventy years and must adjust to whatever changes may come about —and they remain consumers throughout that additional seventy years. When I spoke today, I was thinking in terms of what happened in my one lifetime (which isn't yet seventy years long) and with a much lower population. I am very much concerned about what will happen in the next sixty years (my age) with almost twice as large a population. When I came to this country first I think there were ninety million or 110 million only, and the changes I have seen have come from that small population to this one. Now what if we double to 370 million? This is the thing that perturbs me, and I'd like to say one more thing in rebuttal to you, or at least in answer. I am very glad to hear optimistic reports, and I like objections to my pessimism, I assure you. But I think we can gain more, possibly, by not being over-optimistic, and I am afraid of the *rate* of increase—not the sum total necessarily—but that the rate will exceed our capacity to adjust to the rate of increase and to find new techniques. And any break in a complex economic system such as ours—take the withdrawal of petroleum for instance, which will *some* time occur—if we haven't had time to make the necessary discoveries, technical developments, implementation of a program, with its rapidly burgeoning number of people, then this one little thing could trigger off a catastrophic drop, rather than a gradual one, as you predict and I wish—of course, I *wish* that neither of these, either gradual or catastrophic changes will take place.

Fraser Darling: We've got the idea that Professor Cowles is a pessimist. I'm another. But we are faced with a problem nevertheless, and what are we going to do? We have got to think out ways of tackling this problem, and I would like to just take up with Dick Leonard what he said, in effect: "If I thought this was going to be the end—three or four generations hence—I couldn't go on." Presumably, he is an optimist. Well now, I think we have got to get rid of every illusion we ever had, including that of the expanding economy, which I think is the greatest continuous illusion that we could *possibly* have. We mustn't think in terms, really, of the ends. The great thing is our behavior towards those ends, and I think perhaps we need our greatest courage to drop our illusions. Perhaps we cannot do any good at all until we become completely de-illusioned. At least I believe so. The end is there, but we don't really work for the end—we work for what we think is right towards that end, even if we do end up in disaster. Perhaps, as I say, that needs a greater courage.

Now, what I think has not been brought out by the discussion, or Professor Cowles, is that *we* are thinking in terms of civilized nations moving towards the concept of wilderness protection. But Professor Cowles has been speaking of Africa, where I imagine the ratio is about ten to one of *un*civilized people. And when you are trying to keep wilderness in the face of an enormous number of uncivilized people, it isn't the attitudes of mind that we have developed which count. One must remember that the greatest check to population growth in our world is a *rising* standard of living. I know you say also that a slight drop in the standard of living also checks population, but nevertheless the general trend is that with a rising standard of living the birth rate goes down. Well now, here are Africa and Asia, with very low standards of living, and wherever a low standard remains the population will increase inordinately—and especially as we go in at one end (and, I think, the wrong end) and help that increase in population. But if we do try to tackle this problem, it seems to me that education is the only possible means by which to raise the standard of living and lower the birth rate. In a place like Africa we *touch* on education; the idea is spreading. In Ghana education has gone quite a long way (much farther than in any place else in Africa). But what are we doing? Educating men and not women. Now the position of women in Africa is generally low indeed. I don't believe that any nation can become civilized while keeping their womenfolk in a low position in society. If *we* go on educating men in Africa, while their wives remain at jungle level, it means that all those children are being reared at jungle level, because it's the women's standard of living—their notion of life—which really counts in the early education of children. Until you can bring the womenfolk of Africa and Asia along at the same speed as you educate the men, you cannot hope for any different attitudes. We start from scratch with every generation. This seems a long way from wilderness, but I am sure it's a very important part of it.

EDGAR WAYBURN (Director, Sierra Club): Professor Darling's remarks have caused me to switch what I was going to say. I think he makes a tremendous mistake in saying that the birth rate always drops with an increase in the standard of living. If this is the case, what has happened to the United States? As we have achieved what is generally conceived to be one of the highest standards of living, we have increased our reproductive capacity (as well as our ability to keep people alive) a tremendous amount, and our population is doing the very thing that Professor Cowles has been talking about.

As a conservationist of sorts and physician for a longer time, I would like to take issue with Professor Cowles on the position of the physicians. I agree that they are perhaps the personification of all that is presently wrong with what we are doing, in that they have allowed us to increase more rapidly and to keep our presently existing people alive. I would ask the biologist: "what are we going to do about it?" We have now reached the position where we are in the extremely enviable position of having the highest standard of living, of being able to do more with our available time than we ever were before—of putting ourselves in such a state that we *need* to do something with more available time in order to survive comfortably—and now reaching that position, we don't know what to do about it, as you have so ably pointed out. How, then, do we start as of now?

PROFESSOR COWLES: Well, the matter of wise guidance of leisure time is, I think, a psychologist's problem rather than a biologist's, so I'll have to beg off on answering that question. With respect to physicians as the epitome of all that is evil in our society, this may be true until you get sick. Then the shoe is on the other foot. As to what they might do, I think here they could be emissaries of balanced population. They are surely as intelligent as farmers—and the uneducated farmer knows that he cannot keep more than so many head of stock per acre. A physician could point this out with respect to humanity. Then, as to what we can do about this, the matter of birth control is a rather touchy thing. It is too technical —what devices we have now—too technical for the most ignorant people to apply, and this would include foreign countries. And yet there are techniques that have not been exploited or mentioned on which some research is needed, and birth control could be an easy and simple thing, usable by ignorant people, provided they had the will to do so. But this again is a psychologist's or sociologist's problem, not a biologist's. The mechanics are here, the devices.

I would like to take a minute or two if I might, Mr. Chairman, for a curious thing that has been boiling around in my mind for some time—three years. This is the economics that might be applied in limiting populations. I have thought of all the possible things that might be done, and have come to the conclusion that none of them are feasible unless we can appeal to the crass financial motive—the motive which does tend to limit births when the economic conditions get hard. We give bonuses for having children. I don't see why we shouldn't give bonuses for not having them. One seems as logical as the other in terms of our dilemma. Could this be economically feasible? I inquired as to cost of education through high school: roughly $5,000 in the State of California. Then every child that isn't born would save us $5,000. Some sort of award for not having children could be given just as logically as exemptions; allow a person to take his choice. I assure you that although it seems funny to us, if you give it thought you will find, in view of the economics of the situation (the new schools, new streets, new resources) that a bonus for not having children is fully as logical as exemptions for having them. It would be financially a self-liquidating proposition. I suggest that you look into the economics of it, and I think you will be surprised at the conclusions you will reach. I have worked at this from several different angles, and it seems to me economically feasible and desirable. Just to make one suggestion, if a bonus of say $600 (equal to the exemption) were given for not having children (this would have to be given only to the women) we would save the cost of education for the child not born, and we could thus repay the bonus. Best of all, it would act on a eugenic basis. The reward would be most effective in the poorest and least educated and least forward-thinking part of our population: those that are usually dependent, those that require social security and unemployment compensation (the least employable usually have the biggest families) would benefit the most. We could dispense with some of these awards, and let the burden of financing the family fall on the bonus for not having a child.

STARKER LEOPOLD: According to Bill Vogt, who is with the Planned Parenthood Foundation, this very idea of differential taxation is being considered in Japan and India—that is, increasing the taxes upon a family as the number of children goes up rather than decreasing them as we do. This, of course, is no substitute for education—for a people as a whole wanting to limit their numbers—there are many steps that have to precede that. But this is one of the techniques that is already being explored.

And before I call on anyone else, Ed Wayburn raised a question that must be answered. The birth rate in the United States, Ed, has been going steadily downward for some time; but the death rate has been going steadily downward even faster, and the so-called demographic gap between a dropping birth rate and a dropping mortality rate, is accounting for the present increase. Both are falling; it's simply a differential between the two.

EDGAR WAYBURN: I have discussed this with the Secretary to the Minister of Health in India, and he proudly informs me that the annual increment of population in India is now dropping from five to one million per year, through the efforts of the Government, and he believes that India will shortly surpass Japan as the most enlightened nation in this regard.

FRANK FRASER DARLING

Wilderness, Science, and Human Ecology

Dr. Darling is a most eminent ecologist, and the author of many handsomely illustrated books on this and related subjects. Much of his work was carried on in his native Scotland, where he studied reindeer and human ecology in the Highlands, birds and seals on the western coast and coastal islands. Recently he has done research in Africa, devoting himself to wildlife conservation in relation to land use and in relation to the nutrition of the African people. He has also affiliated himself with the Conservation Foundation.

Every ecological community has a unique complex of energy conversion cycles; these are the "physiology" of the community. When man changes the environment, he disturbs the workings of this communal "organism"; energy conversion cycles are broken and their courses changed, particularly those which vitalize the soil—that upon which all else depends. Wilderness communities have the greatest physiological complexity or "health" their regions can provide. Man's machinations destroy a delicate balance by simplifying these natural dynamics. Therefore, Dr. Darling argues, research into the undamaged conversion cycles of pristine areas is an urgent necessity. The following paper is a verbatim transcript.

THE VERY TITLE of this paper may give a smile to the skeptic: it may imply that human ecology is not a science, and admittedly it is one of those new band wagons. Some people say: "What exactly is human ecology, that isn't covered by social anthropology, epidemiology (in its widest sense), sociology, or certain interpretations of geography?" I think we can be content to say that human ecology is largely an attitude of mind and a way of approach to certain problems of man's physical and organic environments. C. C. Adams (the veteran American ecologist) said well over a generation ago that ecology deals with process, and I think that statement still needs emphasis when one is dealing with human cultures and their environments; cross-sectional interpretations, however detailed and accurate, are not good enough. I have, therefore, hazarded as definitive of human ecology that part of the science which deals with the reciprocal inter-relations of man with his animate habitat, of the influence of the habitat as a whole on social structure and behavior, and of the social system on the animate habitat. (I shall mention again *the influence of the social system on the animate habitat.*)

I do not wish to dwell on those aspects of the human need for wilderness which have been expressed so often and so eloquently by many contributors to previous Sierra Club conferences. We can assume that those mystical awakenings of the human spirit which moved the young Wordsworth are welling up the stronger in an age of increasing stress. He gave us that wonderful line: "On the solid ground of nature builds the mind that rests for aye." We are trying in this conference to answer with firmer discipline the question of why wilderness has such great scientific importance. I come from a country where true wilderness is hard to find, if you would define wilderness as country carrying its natural vegetation and the associated fauna, unaffected by the activities of man beyond his hunting-food gathering stage of development. If man is completely absent, all the better; nevertheless, the necessarily small populations of primitive hunting-food gathering man can be accepted as part of the indigenous fauna.

It has fallen to my particular lot to show what degraded, devastated habitats are those beautiful hills, moors, and glens of the Scottish Highlands: islands where the human population of large areas may be as low as two to the square mile. You would scarcely imagine that in Great Britain, where the average is about 680 to the square mile, but you have a big empty country in the Highlands, where you can drive for some hours without meeting any other car or seeing a house. These hills look wild, and no one can doubt the bare bones of physical grandeur, but they are not wilderness. They have been combed through and through by man's animals, particularly the sheep, and fires have been a deliberate part of management. The only true wilderness there is to be found on some mountain tops, where fire cannot get and the sheep but rarely, or on sea cliffs. My work has been to find out how the deterioration occurred and of what it consisted, and at the end, after seeing deterioration where many people see only remarkable beauty, I needed to get out for a while, and either enjoy a beautiful English countryside, where man has developed harmoniously with his environment in change, or find somewhere a true wilderness. In that search, I came to North America ten years ago and have come several times since, and I have been several times deep into what is still a primitive Africa. Wilderness, by my own severe definition, was still hard to find, and there was a good deal of heartache—wandering around through the logged lands of northern Wisconson, the overgrazed lands of the Southwestern ranges, the overburnt sub-Arctic areas of Alaska, the fire-distorted plateau of Africa—that large central land mass—and even on the wild bare hills of the remote Nyika Plateau in northern Rhodesia, where the glorious high-mountain forest is reduced to a few patches of less than 100 acres. The joy was in finding the beauty of a "hammock," in southern Georgia and northern Florida—quite untouched, a beautiful saucer, varying from oak and pine on the outer edges, to cypress in the middle. I remember penetrating through to the middle of that hammock and seeing an egret fly up into the top of the trees, which seemed an expression by that hammock that it was pristine. I walked through Muir's "country of light," your Sierra. I was also fortunate to get into the goose-breeding grounds of the Yukon-Kuskokwim delta and into the Brooks Range in Alaska. In these places, I did find true wilderness.

At such places one cannot help stopping for contemplation. That is what you go for. I could not comprehend, but at least I was able to apprehend, that these wilderness areas represented the states of greatest organic complexity which those environments could provide. Such states were relatively simple in the tundra or the High Sierra, but the eco-system of a hammock, or an untouched piece of African high forest, is extremely complex. I don't know whether any of you have read Paul Richards's book on the tropical rain forests, or the biological review in which he starts off by saying that within the rain forest there are over 3,000 species of woody plants exceeding twenty centimeters in diameter of trunk or stem. It is terrific—the complexity in this very old life form, unlimited by cold or by lack of water. It is one of those plant systems that we are only on the fringe of—we don't understand their full complexity as yet.

The value of wilderness to science, put baldly—very baldly, and not at all sentimentally—is the provision of study areas of pristine conditions. (I am sticking now to science: what we know, not what we think and dream.) Any eco-system represents a complex of conversion cycles, of energy flow. The elucidation of these means an understanding of what I would call the "physiology of community," which we urgently need for the proper planning of land use in a world of shrinking acreage and growing human populations. If determination of these conversion cycles in true wilderness conditions is possible, we can assess what may be called the voltage and amperage of different habitat types and eco-systems. Thereafter, investigation of changed conditions caused by human interference or usage could be compared, and we should have some notion of biologic efficiency. The fact that a changed habitat may canalize more energy through the human species, although the actual energy flow of the system was reduced, would be no good reason for saying the change represented greater efficiency.

Just let me give you an example here of the effects of wild lands grazing. You had it through the Sierra—we have had it for many years through the Highlands of Scotland, the southern Uplands of Scotland, and the Pennine Chain of England. There is no doubt that this changed land use, from rather poor forest, has canalized more protein through the human gut than the normal land production of that area. But it has been done at the cost of deterioration. We have to consider this from the beginning when we tackle wild lands. Take a place like the west Highlands of Scotland, where you've got sour land, sour soil, high rainfall, and steep slopes. Well your very good countryman Albrecht, at Missouri, would ask straightway: "What is the chemical answer there?" It is cellulose production—water, moderate temperature, high rainfall, steep slopes, with very poor calcium relations—the answer is cellulose production through photosynthesis. What has happened there? The trees have gone—you put on sheep and you ask for protein in the form of meat and in the form of wool. Well any chemist—or, as Macaulay would say, any schoolboy—will tell you that to synthesize protein properly you must have a solid calcium-phosphate balance. You cannot build protein efficiently without that. Yet we have taken the protein off, in the case of the Scottish Highlands, for 150 years. Now that has been done at the cost of deterioration. As I say, although we have canalized more energy through the human gut, we have not arrived at a greater efficiency of biologic turnover in that kind of country. These are the sorts of problems of land use one must always be trying to solve.

We may take it for granted, I think, that wilderness areas represent natural mixtures of climax and successional states; ecologically, the energy flow and the conversion cycles are relatively constant. To what extent deliberate human change in former natural conditions results in decreased, increased, or sustained energy flow, it is important to discover. Agricultural systems on good land mean the injection of capital, skill, and hard work: what were climax states have been set back to an early stage of succession, the crops being intrinsically those of early stages. I mean if you fell forests, or you plow prairie, and you grow wheat or maize in that place, you are setting back succession to the early stages and growing annual crops instead of the deeply differentiated and perennial plants which are characteristic of later stages of succession. Only very good land will withstand such traumatic treatment for long periods, and good land, as far as we know, will go on indefinitely—or as long as you continue to put in capital, skill, and hard work. When that is done, the energy flow is very high indeed, much higher than that of the previous wilderness state. The introduction of the clover crop and the establishment of rotation farming on enclosed land in 18th Century England is an excellent example of sustained increased energy flow from a simpler eco-system than that of the climax oak forest.

Comparatively few regions of the earth will take this sort of treatment, and very few do receive adequate capital and skill. Certain areas, among which have been the California Sierra, are subjected to wealth-gathering by pastoralism. This is wild land pastoralism and not the kind you put any work or capital into. You gather wealth with the mouths of sheep—one man can put out a thousand mouths and manage those thousand mouths—and they are tremendous wealth-gathering organisms. They can pull that wealth in, and this is done without conducting any capital works or applying any skill other than to extract the maximum of wealth from the wild lands. Some of these places have suffered irremediably, and how far such areas as the Emigrant Basin and the foothills of the Sierra have suffered, I do not know. Apparently you did decimate the bighorn sheep without actually shooting it out. Doubtless the herbage complex was damaged in some way, for the practice of grazing with closely bunched exotic animals such as sheep depletes the vegetational complex.

This is a point where the complexity of wilderness should be more fully understood. What is the complete herbage complex? Have you got a full list from the Sierra, with not only the list of the things present, but the associations and proportional incidences? If you have, you are lucky, because few geographical areas are so provided. Plants do stay where they grow, for the most part, and though some are tiny and inconspicuous, they yield their presence to the enquiring eye. The animals of any habitat community may be harder to find. There are not only those of considerable size moving above ground but the hosts of invertebrate species below. The Danish ecologist, Bornebusch, has stated that the bio-mass of animals above ground is equalled by that of the animals below ground—a very arresting thought! Each of the many species represented is doing a job of conversion of matter in a closely-niched organization. Practices such as logging, firing, overgrazing, and impaction of the soil from treading lead to loss of species from the habitat and therefore to breaks in the conversion cycles, in short, to a lowering of voltage and amperage.

I think I can give you an example here. An American botanist, a very old gentleman indeed, was talking to me about the pristine quality of certain Eastern woods in the United States. He said that he doubted whether there were any, but that if he were to study the possible stage of any of these woods, from the pristine to the completely ruined, he thought he would study the Myriapoda, the millipedes. That was extremely interdisciplinary for a botanist to say—that if he wanted to judge a botanical situation, he would go over to the animal group, the Myriapoda, to find out the stage at which that forest was. His view was that these animals were extremely sensitive to change in the environment, and very strikingly, about three years ago, a member of the staff of the Nature Conservatory in Britain (Ovington, who is at present in this country, and also Overgaard Nielson, a Dane, who was working at Oxford) discovered that the pill millipede, in these Eastern woodlands and at home too, was an absolutely essential species for the conversion of detritus from brachypodium grass into soil. Well, if you log and remove the woodland, even if you re-grow it afterwards, you lose your pill millipede—it is extremely sensitive. Once that creature is gone, the conversion cycle is interfered with immediately. It is just one example linking up with this remark of the old gentleman I spoke about. This change from the complex to the simpler by human interference is the opposite trend to Lotka's (a mathematical ecologist) axiom that the collective activities and effects of organisms indicate a direction of organic evolution toward maximal energy intake from the sun and maximum outgo of free energy by dissipative processes in living and in decaying dead organisms. The advance towards the complexity of the climax state shows a directional tendency toward a higher metabolic rate for the whole eco-system. Energy flow is maximized in that way.

Imagine the effect on the complete and integrated utilization of a habitat in Africa, where there may be thirty species of hoofed animals present. Man comes into this state, and he eliminates these and replaces them with three exotics: cattle, sheep, and goats. The result is progressive deterioration of habitats which are unfitted to sustain such activity. Think of those thirty ungulates, from the elephant at the top down to a hare-size antelope at the bottom. Each of those species is competing in a minimal fashion with all other species, because after all in evolution the whole trend of each species is to differentiate itself slightly from other species to make a smaller demand, a demand which is different from any other species', on the resources available. In Africa, you have this extremely rich fauna of ungulates. For example, there is the elephant; he is the great path maker in Africa; he honeycombs the country with his paths. After him come all the other animals, moving along these paths and able to take advantage of the environment as a result of his having done this preliminary work. He again can reach very high. He takes off in a very, very rough way the top browse of very many trees, and that prunes them down. The trees begin to grow a great deal of browse from their lower parts, and this provides browse for species of antelope. They again vary in their demand for browse or for grazing in the clearings made either by fire (natural fire) or by different water situations, and you get this extremely intricate niching of these species. Their utilization of the habitat is much, much greater but entirely without deterioration as compared with the three exotic animals which man brought into Africa. I would say that there are very, very few areas in Africa that can withstand sustained cattle ranching or cattle farming. It is a humbling thought, if I am right, that Africa is not a great agricultural country; it is only in pockets that you can get a sustained agriculture. Yet the whole trend is to talk of Africa as the great rich place of the future, where enormous riches of food and what-not are going to come out. I may argue this a bit more in discussion, but I will leave it now.

I would suggest that research into conversion cycles in the pristine conditions of wilderness is not being pursued with sufficient vigor. We are apt to be concerned with the ecological relationships and behavior of the more obvious mammals and birds and with the plants usually considered to supply food and cover to these animals, and we forget the immense bio-mass represented by the invertebrate animal population and the intricate function that bio-mass fulfills. It is all linked. We cannot consider the mammals as something apart, or the birds as something apart. We have very much reached the stage of considering the mammals and birds in relation to vegetation, but we have to go deeper still into this great complex of species which many of us don't even think about. Human activities are so obvious in their effects on the stocks of mammals and birds, that observation of such effects and the deductions we draw may constitute wildlife ecology as we know it. But human influences are equally great on invertebrate populations of the soil and those linked with vegetation. The preservation of sufficiently large patches of wilderness is an urgent scientific necessity, which through research into the physiology of communities could yield results of vital interest to the wider fields of agriculture, forestry, nutrition, and soil science.

I have used this term "physiology of communities," and you might ask me why I can't call it plain "ecology." The reason is that the emphasis is on function in the supraorganism represented by any biologic community or eco-system. When I use the word "supraorganism," its meaning is that the whole is greater than the sum of its parts. The trend in physiological studies of the higher animals and man is to relate all the functions of the body to each other for a greater understanding of the psychosomatic whole. Equally I think we need this kind of teamwork leading to comprehension of eco-systems as wholes as well as in ecological studies dealing with animals and their food habits—which are presently sort of the backbone of wildlife and wilderness ecology.

I want to come back a little to Africa. It is very much in the news just now, and the general interest in Africa is extraordinary at the present time. I have noticed this very big change since I was last in this country. It is tropical, and I wonder if we realize the impact of African and European man on the environment of Africa as well as we might. Africa, as I said a few moments ago, is not a rich country; it is a poor country. There are immense areas of the central African plateau which are composed of red senile soils. Even a commission of FAO from Rome, which visited there some seven years ago, said it was unable to suggest any better system of agriculture than the shifting chitemene system which is being practiced at the present time in central Africa. That country is normally covered by forest, rather poor forest, in which there is a good infiltration of sunlight down to the floor, and the cycle of what is called chitemene gardening is that of cutting a circle in among the trees, burning the wood and growing crops for perhaps three years, and then leaving it for forty years to recover. As long as you have a primitive and low human population, there is no damage whatever to that environment. If you fly over certain areas, you can see these little rings in the Miombo Forest, and you know that there is a low population. But as the population increases, you see these rings coming closer together, and again as you fly over the area (the airplane is one of the great tools of the ecologist) you see the rings beginning to intersect, and then you know that that country is in trouble. If you have to reduce your times of coming on to that land to every twenty years, or every fifteen years, you are creating desert in the long run. That is happening now; there are many areas where these intersections of chitemene circles are taking place, and you know that there is overpopulation: a demand for resources from that country which the habitat is unable to sustain. What are we going to do in these places?

Again, you get areas where there is considerable difference between the rainy and dry seasons. Six months of rain and six months of absolute dryness. In the rainy season it is remarkable what lush growth takes place. I suppose I am one of the last people who will ever make a foot journey into the wilderness of the west side of the Luangwa Valley in Northern Rhodesia. That is a valley 500 miles long and well over 100 miles broad, in which there is one perpetual river running down the middle. All the side streams dry up in the dry season. Now there is a wealth of wildlife in that valley. It is still what it was many years ago: a vast array of wildlife. The integration of land use by that wildlife is quite remarkable. In the wet season, the whole wildlife is spread over the whole valley, utilizing it. In the dry season, as the rivers dry up, the animals come down to the river banks and the plains of grass alongside. Then you say, what a vast assembly of wildlife! What an enormous number there is! But they are the concentration of population that has been using this great valley all the rest of the time.

Now they have established two very large reserves on the banks of the Luangwa River. Splendid; there will be no killing at all in those reserves. (That is not so good, I think, because it is not in line with the way we are thinking at the moment.) But along comes the agriculturist. He says: "Look at this beautiful bottom valley land; we could grow cotton there; we could grow sorghum, Kaffir corn, etc., in large quantities." They have started doing that in places near the foot of the valley, with the result that the wildlife impinges and pretty well clears out the crops. Then, of course, there is a cry for the removal of the wildlife, which is damaging agriculture—a terrible thing. And there is a very real body of opinion among administration and the agriculturists that this bit of valley bottom land is more important than the valley as a whole, with its vast quantity of wildlife.

Well now, I feel that this is the wrong approach to the land use of the wilderness. Wilderness is scarcely ever large enough now to be left utterly and absolutely alone. Wilderness has edges, and it is on the edges that you get wear, wear from the outside. There is impingement all the time, such that you cannot really sustain the conditions that you would like. I can think of places in Africa where the elephant population, even in 8,000 square miles, cannot be accommodated: they must go out on a migration and back in again. If you are going to neglect that size, you must do something about the populations of animals even within the wilderness areas.

I think probably the newer concept in parts of Africa would be to manage these areas which will not withstand farming as game areas, in which a crop of protein could be taken off as a secondary product of the area as a whole, leaving the pristine vegetation. Be very careful of the amount of protein that comes out of there, but quite definitely (and this will go hard with many of you here) some crop will have to be taken off, because within that wilderness area (even if it is 8,000 square miles) there is not enough space. If you leave it utterly alone, you will get a building up of populations using the sanctuary value of that area, and you will get punishing over-use of that great wilderness area, and that means deterioration again. It is necessary to take this crop, and in Africa the great nutritional need is protein.

What do most of us do when we go into some new country of primitive people: we set them growing more carbohydrates, and we give them big pot bellies, and that is progress. That isn't what they want. If there is anything likely to produce dissatisfaction it is a pot belly full of mush. You feel all the better after a piece of steak. The African is quite likely to want that protein meal—he craves it—and strange as it may seem in that hot climate, the protein is very necessary, very much more so than it is even farther north. When you get to the Arctic, fat is the great thing; you crave fat as well as protein, but in the tropics protein is a very necessary thing for human health. Whether you are going to accept unlimited population increases in Africa, or whether you are going to have a well protein-fed population of limited size: that is the problem. There is no doubt that we could manage these wild lands of Africa much more efficiently for a protein crop for a limited human population. But this is not being considered; there is something derogatory about the wild animal. It must be better to use the domesticated ones. The Jacobs of this world are much better esteemed than the Esaus, you know. The whole trend of administrative policy in Africa is to remove the tsetse fly, get into these areas, and farm them with cattle—in spite of all the past indications that that will mean deterioration of habitat.

These are the problems of wilderness in Africa which many of us are going to be faced with, and I shall certainly do everything possible I can for the maintenance of wilderness in Africa as the most productive state in which that land could be left. I am cutting out entirely the emotion that moves every one of us in this room: the emotion of love of wilderness for its own sake. But we still have to face this population pressure, this political pressure of a very high order in Africa; we have to shape up to what is coming. You can stand on principle. I will very definitely stand on principle, but it is no good standing on principle to the exclusion of the realities. It is just being silly to be an Ajax defying the lightning. We've got to see it in terms of this growing awareness in Africa, this growing population and administrative policy as a whole.

DISCUSSION

Starker Leopold, *Discussion Leader*

Leopold: Dr. Darling has reiterated for us one of the basic principles of ecology which all of us learn and can transmit rapidly to our students, namely this: that the processes of evolution of communities, plants, animals, and soil are always towards complexity; that the processes of our use of these communities are always towards simplicity. In reducing the complex to the simple, we are channeling the flows of nutrients and of energy from the circular path which is the natural path in any evolved community to an outflowing path, in order to maintain ourselves and our domestic animals. The capacity of different parts of the world to withstand this diversion of the energy channel varies greatly, as we all know: from the one extreme, glaciated northwestern Europe, which has withstood this channeling over many centuries, and from all we can see will withstand it indefinitely in the future, to the very friable lands that actually compose the bulk of the earth's crust and the extreme examples of which are the desert or the equally friable tundra, which is nothing but a physiological desert, droughty because of ice rather than lack of water.

By diversion of these energy flows, we are maintaining ourselves at the moment, and going back to Professor Cowles's talk, we are trying by diverting more and more of this energy to maintain more and more people. Some would say that the technologies of agriculture can compensate for this increasing need by use of machinery and fertilizers which do increase yields per acre, but all that this is doing is accelerating an outflow of nutrients. In other words, technological agriculture is not in any sense compensating for ecologic disturbance; it is simply accelerating it, and in the case of friable lands this leads sooner or later to loss of fertility and loss of production. This basic theme which Frank Darling reiterated for us, and for which Africa is one very good example, certainly should guide our thinking on all land-use problems.

Luna Leopold: I would like to ask Dr. Darling to comment on a question which relates to the interaction of industrial and agricultural development in Africa. But before asking the question directly, I would like to make a very brief statement as an introduction.

There are trends to be seen in all countries of the world towards the substitution of atomic energy for other forms of energy for many different reasons: the decrease in petroleum resources, the absence of coal (which may be the case in certain parts of Africa) and the word, which trembles on the lips of some conservationists, that the development of atomic energy would relieve some of the pressures on the wilderness for the building of hydro-electric plants. But you might be interested in an article published a couple of months ago in the *Atomic Scientist* by Wallace Delaguna, which emphasized, as it is not very generally known, that the radioactive waste from atomic reactors built for the purpose of energy development is perhaps a more serious problem than is generally realized. Delaguna makes the statement, that at the rate we are planning to develop atomic energy, by the year 2000 we will be developing on an annual basis (if I remember the figure) approximately 10^8 curies of strontium-90 alone. This is only one of the many kinds of wastes. You could not dispose of 10^8 curies by dilution into all the water in the whole world, including the glaciers, and this is on an annual basis. There is the possibility then that atomic development, in industrialization of a continent like Africa, might be called upon because of the necessity owing, let's say, to lack of the kinds of coal resources that we have in this country. Is there any talk in Africa now about the kinds of effect which the disposal of radioactive wastes from this industrial development tied to atomic energy might mean for African agriculture in the future?

Darling: I don't think there has been any thought of that kind at all. I don't think that degree of industrial development has been really seriously thought of, although we know perfectly well (as Professor Cowles has said) that there is very considerable industrial development in the South. South Africa's industrial output isn't to be ignored at all. But Africa, of course, is a big place, and I don't think that that has been thought of at all seriously. What I would say possibly has been thought of is what is going to follow atomic energy in many ways. Energy use is rather like air travel: as soon as an airplane comes into use, it is really obsolete; it is the one on the drawing board that counts, and atomic energy is probably only a stopgap between petroleum and the conventional fuels and gathering in energy from solar radiation. If that comes about, of course, Africa would be in just the right spot.

Eivind Scoyen (Associate Director, National Park Service): I have a comment on the management of wilderness areas, such as National Parks, which are used a great deal by the public. The entire system of development areas and road corridors in Yellowstone Park was complete in 1908, and the only thing that has happened since then (when they had about 20,000 visitors) up to now (when they have about 1,500,000) has been that the facilities have been expanded within those corridors and those developed areas that are already established. But no new corridors have been established to handle the tremendously increased number of people using the Park.

Secondly, I think another very interesting and important part of this problem is the providing of alternate outlets. I view this whole question of recreation as a great flood control project. If you let these people flow into the parks and forests uncontrolled, then great damage will be done. But if upstream along the watersheds of our highways, etc. you can put dams and diversions where these people can go into alternate areas, I think it will help the problem a lot.

Finally, there is the problem of waste. I had dinner one evening with a professor from the University of London who was considered the greatest English authority on American history. We asked him if he were quickly, in one sentence, to describe the American civilization what he would say. He said: "That is very easy: it is the most wasteful civilization that ever existed on earth." Now I think conservation is the prevention of waste. I don't want to get into the farm problem, but if overproduction is waste, then we are actually paying a large sum of money to waste our resources. This is a different sort of waste than was just mentioned, but I think that as conservationists we ought to point out the whole problem, of which the wasting of wild lands resources is only one aspect.

JAMES ROOF (University of California, School of Forestry): I would like to ask Dr. Darling if his remarks concerning Africa also apply to the United States—specifically, the management of wildlife areas.

DARLING: Well, in a way it is you who have been the pioneers in this field. Insofar as you can keep wilderness area untouched, it is to be untouched; you have ways of taking crops off on the outside, but at the same time you must watch the densities which may be building up within the limits of the wilderness area. I think it is worse in a tropical area than it is here, but if you take Yellowstone Park, which is almost a symbol of the American wilderness dream from its earliest times (we know how that dream has changed in texture, but nevertheless it is there), Yellowstone Park is the outstanding symbol, and you know what the elk is doing there. You cannot consider the Yellowstone Park as a wilderness area to be left untouched any more. You have to take off a considerable crop of elk every year, although because of general attitudes which are not yet ready to see cropping of wilderness areas or the shooting of elk, it is better when there is a clump of trees between whatever happens and the road. That is the way general attitudes are. They will have to change, and I see nothing derogatory to the principle of wilderness in keeping that clear eye on the population of animals within the wilderness, and when it is the moment to remove some, to do so. When you see range being overgrazed by wild animals, it doesn't take much more research to solve the problem; something has to be done to remove some of the animals that are doing the overgrazing.

PROFESSOR PAUL ZINKE (School of Forestry, University of California): You were describing natural eco-systems as probably being those in which man was present in the hunting stage. Do you feel that man has a natural part in the present eco-systems that are developing?

DARLING: As soon as he ceases to be a hunter or food gatherer, he ceases in my thoughts to be natural. As soon as ever he scratches the ground and grows something or processes something, and especially when he begins to move resources from one place to another, that is a very, very dangerous stage in the unnaturalness of man—when he starts tapping a resource, especially an animate resource, for its removal to a population elsewhere. A hunting, food-gathering man simply cannot exist in large numbers in one place, whereas the human being is intensely social. It is his great desire to be gregarious; and he made the big breakthrough in the Neolithic age by establishing an agriculture which gave him that buffer, that store of food which enabled him to be gregarious. We know of places like Kotzebue in the Arctic, and wasn't it Medicine Bow in Kansas, where the Eskimo and the Indian have gathered. They could only gather about two or three weeks at a time; then they had to get back to the range, because they just couldn't hold up that standard of gregariousness any longer. Well, as soon as man makes this breakthrough into highly organized gregariousness, he loses his place in the natural order and ceases to be indigenous fauna.

Mrs. Neil Haig (Seattle, Washington): I just wanted to ask Dr. Darling one question. He spoke of game going over from a wilderness area into the next area and invading it. Do they use buffer zones in any of the wilderness areas, and how wide should a buffer zone be, for instance, between a National Forest and a National Park? If it is cut right up to the line, it will cause a blowdown. Would a buffer zone help solve the situation for recreational areas which are next to wilderness areas?

Darling: I think that is a very good point indeed. Actually, in many parts of Africa there are perfectly good game departments, and these chaps have done a wonderful job in arranging what they call controlled hunting areas around either national parks or game reserves. But unfortunately, game departments are not in general popular with administrations, and administrations are always on top. A game department is looked upon as a luxury department, and therefore if there is any question at all, the administration will tend to override the game department. Northern Rhodesia, for example, has the most up to date system of controlled areas around their reserves that you could possibly imagine—a perfectly good workable system, but it is breaking down because it isn't administered.

You yourself spoke more from the logging point of view which is very much to the point. To put it in a way, a forest must have a good skirt. If you can begin to see a forest's knees, something is wrong; it is much better that it should have a skirt well down to the ground. The shanks of a lodgepole pine should not be seen from outside.

KARL W. ONTHANK, *CHAIRMAN*

Report of Committee on Recommendations

All the Wilderness Conferences have culminated in a series of recommendations, formally put to a vote in the formal session, to express a sense of the meeting but to bind no individual, organization, or participating government agency.

Dr. Onthank's committee on recommendations was appointed by conference chairman Dr. Miller to include Darwin Lambert, of Ely, Nevada; Professor Paul Zinke, of the University of California Forestry School; and David Brower. Charlotte Mauk served in Brower's stead when illness prevented his attending.

RESOLUTION 1

Wilderness as a Scientific Resource

The biological sciences, especially those which emphasize relationships and interdependence of plant and animal life communities, are being recognized as of critical importance to the welfare of mankind and the nation. In order to evaluate life processes in areas where man has changed the face of the Earth, it is necessary to have a variety of areas still in their natural state for purposes of comparison—to serve as "benchmarks" with which to relate the effect of man's activities on the plant and animal life upon which his own life depends.

The destruction of life communities that still remain in their natural state, such as the wilderness portions of National Parks, National Forests, Wildlife Ranges, and other parts of the wilderness system, would be an irreparable loss to man's understanding and survival.

Therefore, as an essential step in the program of preserving areas in their natural state, and to encourage the urgently needed biological-ecological research which must include work in such areas, we recommend the passage of the Wilderness Bill without further delay.

[No discussion. The Resolution was adopted unanimously.]

RESOLUTION 2

Wilderness Research and Education

The proper use of all our public lands requires a better understanding by administrators and lay citizens alike of:

a) the interrelationships of plants, animals, soil, water, and air;

b) the effects of man's activities on these interrelationships;

c) the value of unmodified areas as gauges of our progress toward the best possible utilization of managed lands.

This understanding can be gained only by long-term research, involving every branch of science, on areas that are deliberately reserved unaltered, and by transmission of research findings to a large and receptive audience.

Because the most receptive audience may be found in those persons who seek publicly-owned lands for their recreational values, it is urged that each agency administering such lands undertake a large-scale program including:

a) research on the lands under its jurisdiction, or cooperation with appropriate agencies and institutions in the conduct of such research;

b) enlarged interpretive staffs whose members participate in, or keep in touch with, the results of research and are not burdened with irrelevant responsibilities;

c) utilization of all possible media—displays and exhibits, motion pictures, lectures, and informal individual contact—for the information of the public, so that citizens may appreciate, enjoy, take pride in, and seek to protect the lands dedicated to recreational and scientific uses.

To this end the agencies administering these public lands—especially the National Park Service and the United States Forest Service—should have budgets adequate to support both research and education of this type.

In addition, all other agencies (including universities) concerned with study and management of natural resources should be urged to undertake or support further research on ecological problems affecting natural areas.

DISCUSSION

HOWARD ZAHNISER, *Discussion Leader*

The final sentence of Resolution 2 resulted from the following remarks.

WILLIAM DRAKE (Western Representative, Nature Conservancy, Berkeley): I personally feel that this is probably the most significant recommendation coming out of this conference. The problem of management is going to be the key problem in the whole effort to preserve wilderness, and it is on management policy that all of these controversies focus. Also, the obvious conclusion to be drawn from almost every speech is that only through basic research, in what Dr. Darling called "conversion cycles in pristine conditions," can we understand enough about the natural behavior of wild areas to know how to manage them properly. I think this resolution is certainly very good, as far as it goes, but I personally feel that the speakers themselves presented a much more sweeping problem to us, that perhaps demands a much more sweeping resolution, in terms of a research program.

Two years ago at this conference, it was said that what takes place outside of wilderness is probably more important in preserving wilderness than what takes place inside, and I think the same might be said for the research program. The kinds of research on natural areas done outside the wilderness might contribute more toward preserving wilderness itself than the actual program in wild public lands. The reason I say this is that most of the productive area of the country was once wilderness, and only a very small fragment of it remains so. I think, for example, that research programs in the ecology of the grasslands of the Central Valley, of the great plains of the Southwest, or of some of our coastal areas would be much more significant in contributing basic knowledge, probably because they are closer to our universities and so on than the program of research in National Forest or National Park lands.

I feel that what is needed nationally, before it is too late, is a coherent, comprehensive approach to all of the wild areas of the country, no matter how large or how small, and perhaps we should emulate the British, who established a special ecological bureau you might say to handle this sort of problem. That is: create a kind of registration of all of the nature reserves that are now in existence. Second: inventory all of the eco-systems that constitute the natural landscape of North America; and third: establish research stations which would be clearing houses of information for basic ecologic knowledge. This would be a comprehensive system of research, far more sweeping than just the research on existing public lands, and it would bring together a program that is now scattered around at various institutions throughout the country.

I haven't any specific proposal. I think it is premature to suggest that the United States Government establish an ecologist in its Cabinet, as Dr. Cowles told me the British have considered doing, but I think it is a first step to ask for such a research program on our existing public lands.

LEWIS F. CLARK (Secretary, the Sierra Club): The object of this resolution is to get more money for research in our wilderness areas, if it can be briefed down to such simple language. I hope that in selling it beyond this room, where all are dedicated to this wilderness idea, a way will be found to formulate the ideas incorporated in this very excellent resolution in simple form, so that the layman will get the idea without possessing all the background that we have.

HENRY VAUX (Dean, School of Forestry, University of California): My comment, I think, is very much along the line of Mr. Drake's. The approach to research in this resolution should perhaps be broadened, and not point just to the research groups connected directly with land administration agencies, but should urge additional research in wild land problems, regardless of what the agencies are that may be qualified to contribute. As Mr. Drake inferred, many universities and other groups could make important contributions that might be much more difficult to achieve through research by the administrating agencies themselves.

I think the one further point to make in this connection is that there is a great deal of interest in the matter of additional research on wild land problems of all kinds. For example, in the last few years here in California there has been developed a so-called wild land research plan; it attempts to state, in fairly understandable terms, the most pressing research needed to meet some of these problems that have been under discussion—whether they be of wilderness lands or of non-wilderness wild land areas. Whether or not that particular plan has the proper answers it is important, because it provides a means through which all groups interested in this research approach to the problem can unite and exercise efforts jointly in this direction. Perhaps simply broadening the resolution a bit, to make it support research by all qualified agencies in this particular area of affairs, would be helpful.

MR. DRAKE: I feel a distinction ought to be made: we are not just asking for more research. We are asking for a certain kind of research, and we don't want, with all due respect to the public agencies that have researchers in this room, simply to have more research along, for instance, engineering lines. How to produce more. How to do more of what we are doing already. I think it is very important (Dr. Vaux, I think, hinted at this) to have research that is really basic and that is in a sense detached—as university circles are from the seat of the management problem. We need to produce more people to think on the level that Dr. Darling does, and I don't think such people are very apt to come out of practical jobs of management. I think, to assure the independence of the research that is really to be basic ecological research, that this shouldn't be simply an additional research budget for an existing agency.

Dr. Cain: I am one of the persons who suggested the increase of basic research by the National Park Service; I have since been asked a question: "Where would all those qualified investigators come from if all of a sudden there was a lot of money?" and I want to give a word of encouragement now. The National Science Foundation has been in existence for a few years, and every year it has had more money for support of basic research. I happen currently to be the Chairman of the Environmental Biology Panel of the NSF, and I will describe to you what has happened. In this period of growth we arrived at January with 106 proposals for independent research in environmental biology, at least seventy-five per cent of which had to do with wild lands in the broad sense, and none of which were oriented towards increasing profit for anyone. The total sum requested by these projects amounted to about two and one-half million dollars. The funds available for this kind of independent research are adequate to meet every proposal of the last two years that the panel has judged worthy of financial support. Now where were all these investigators five years ago? They were scattered around the universities and the colleges and the other places without financial support for this kind of activity. Here was an unused human resource. I say to you that if our universities today offered outlets for basic ecological research—where people could get decent employment, in terms of compensation, according to their abilities—we could very quickly raise an adequate generation of investigators, who would find outlet for their interest along these lines. The big bottleneck, in my opinion, has not been the lack of talent, but the lack of encouragement to talent to go in this direction. If the various kinds of suggestion and encouragement that can come from groups like this will promote, and ultimately gain, financial support for such wild land research, the investigators will come, as it were, up out of the bushes.

[The Resolution was adopted unanimously.]

RESOLUTION 3

Outdoor Resources Review

The *Outdoor Recreation Resources Review Commission* is just starting to inventory and evaluate our national recreation and scenic resources and to estimate future needs for them. At the very time this task is getting under way areas recognized as having high potential recreational value, including wild lands, are being opened to competing uses. It is obvious that if such areas are eliminated from future recreational use—of a wilderness type, or otherwise—by action prior to consideration by the Commission, the very purpose of the survey is thereby frustrated and defeated just as it begins to operate. Such contradiction could not, of course, have been intended by Congress when it passed the Act creating the Commission and setting up its task.

The Conference therefore urges all land-management agencies to safeguard from any untimely use for other purposes all such areas of potential wilderness designation and accordingly urges the Outdoor Recreation Resources Review Commission to pay particular attention to the wilderness values of such areas. Examples of these areas include the Glacier Peak-North Cascades region in Washington, the recently eliminated portion of the Three Sisters area in Oregon, the Kern Plateau in California, and the proposed Great Basin National Park in Nevada. To provide an orderly and effective policy and program as a basis for recommendations regarding such areas of potential wilderness, as well as for the immediate protection of existing areas of designated wilderness, the Conference further urges the prompt enactment of the Wilderness Bill as an aid to the program of the Outdoor Recreation Resources Review Commission as well as for the other urgent and desirable purposes that make this a most important piece of basic legislation.

[Resolution 3, in its final form, was the product of a brief discussion, in which it was decided not to eliminate the Kern Plateau as an example of potential wilderness areas.]

RESOLUTION 4

Shoreline Wilderness

That the vulnerability of the wild shores of oceans and lakes is now being recognized is expressed in proposals to preserve such areas as the Olympic shoreline in Washington, representative sections of the Pacific Coast in Oregon and California, the Michigan dunes, and a portion of Cape Cod. The Conference urges upon Congress and the American people the importance of adding littorals that are still wild to our protected scenic and recreational resources.

The shoreline strip in its native condition represents a particularly valuable scientific asset, but is subject to rapid and destructive alteration by such activities as skin-diving and the taking of the littoral flora and fauna.

For protection of this valuable resource the Conference urges appropriate action for preservation of adequate shore areas, including not only the designation of suitable new preserves but also the extension of jurisdiction of the agencies administering existing shoreline parks and preserves beyond the present boundaries at high-tide line so that they may include an adequate portion of the underwater plant and animal community.

[No discussion. The Resolution was adopted unanimously.]

RESOLUTION 5

Alaska

Time still remains for the preservation of a few small fragments of primitive Alaska, but it is rapidly running out. If we do not persist more diligently in our efforts, assets of inestimable value will be lost.

Recommendations:

a) This Conference supports the establishment of the Arctic Wildlife Range and the Kuskokwim and Izembec Refuges. It views with grave concern the prolonged and seemingly unnecessary delay in submitting for Congressional action the basic legislation which the Department of the Interior proposed in 1957 for establishment of the Arctic Wildlife Range. The Conference urges the Secretary of the Interior to take early and specific action in this conservation proposal which he has endorsed and which has received widespread public support.

b) Katmai and Glacier Bay National Monuments, of increasing value to recreation and research, should be given National Park status.

c) Legislation is essential to protect such species as polar bear, walrus, wolves, and others, which will be unable to withstand the effects of increased hunting and destruction of habitat.

d) Wilderness areas should be designated within both Tongass and Chugach National Forests. Establishment of the Tracy Arm-Ford's Terror Wilderness Area including Endicott Arm, in Southeastern Alaska, should receive priority.

e) We respectfully urge upon the people of Alaska the necessity for giving the most careful consideration to the remarkable resources of wilderness and wildlife within the boundaries of the new State. We further request that, before developing any programs which might destroy these resources for all time, they make a careful long-range study of the potentials of these wilderness resources, both to the people of Alaska and to the nation.

f) It is reported that an experimental plan calls for the atomic blasting of a harbor at Cape Thompson on the Arctic coast in 1961. This proposed "new" harbor will not be used as such; will have no specific purpose other than testing atomic power as a dredging tool. It is understood that this area has uniquely important biological qualities which have not been considered in planning the location of this experiment. Therefore, this Conference protests the planning of such a project without full consideration of the results to the natural marine and shore communities affected.

[No discussion. Resolution adopted unanimously.]

RESOLUTION 6

Population Problem

As wilderness is one of the first of the earth's important natural resources to come into short supply as a result of world-wide human "population explosion," the final destiny of all wilderness may hinge on this trend. This Conference, recognizing that both economic standards and the quality of human living are at stake, accordingly recommends that research on human population problems be greatly increased and that social, governmental and other appropriate agencies give immediate and urgent attention to the development of desirable population controls.

[No discussion. Resolution adopted, three of audience voting No.]

RESOLUTION 7

Zoning

Increasing population pressures and the threat to wilderness from competing uses because of lack of adequate areas elsewhere better suited to these other uses require a zoning system to assure optimum use. The setting aside of land for use as wilderness is thus an essential part of the planning of land use and should be recognized as such. Furthermore, the preservation of wilderness should be recognized in the context of overall land-use planning and zoning by appropriate governmental agencies.

[No discussion. Resolution adopted unanimously.]

RESOLUTION 8

Land Restoration

Millions of acres of potential timber lands are not now producing, and the efficiency of timber production from available land resources is far below what is possible. Much grazing land, also, is far below full potential production because of past overgrazing and other denuding influences. Much forest land of greater efficiency in the use of such potential resources, including areas on the National Forests and other public lands that were once productive but are now impaired, would aid the economy and would also tend to reduce pressure for commercial use of wilderness areas.

The Conference therefore recommends that the Congress, the United States Forest Service, the Bureau of Land Management, and other land-administering agencies be urged to put more emphasis on tree planting, reseeding, and other techniques for restoring maximum production on degraded lands available and appropriate for timber production, forage production, or intensive recreational use.

DISCUSSION

HOWARD ZAHNISER, *Discussion Leader*

HENRY VAUX (Berkeley): This resolution, I think, raises an important point that was implicit in our discussion this morning and in much of what has come about this afternoon. It is an extremely constructive statement that can be helpful in minimizing some of the pressures on wilderness areas. My only criticism of it is that it does not go far enough.

I would like to see it go further in one specific respect. It seems to me that the morning's discussion highlighted in a very fundamental and significant way that, in terms of the essential concept of wilderness use, perhaps the greatest danger that wilderness faces is from those types of recreational use that we might define as mass recreation in wild land areas. The increasing population pressure here in California and elsewhere makes it clear to us every day, but there is certainly a great deal that could be done to minimize the dangers to wilderness from pressures for mass recreational development by better utilization of our non-wilderness wild land areas for this purpose. With this in mind, I would like to see this particular resolution make allusion not only to increasing the efficiency of timber production on timber growing land and to forage production on forage growing land, but to increasing the efficiency of recreational use for mass recreation in non-wilderness wild land areas.

I would amend the last sentence of the first paragraph to read as follows: "Much forest land under heavy and concentrated recreational use needs more intensive management if it is long to sustain present and anticipated recreational impacts." Instead of the phrase "tree planting, reseeding, etc.," I would use the following language: "tree planting, reseeding, and other techniques for managment of the resource and its users." Finally, in place of the last four words which are now: "timber or forage production," I would like to substitute: "timber production, forage production, or intensive recreational use." Mr. Chairman, I would like to move this as an amendment.

LEWIS CLARK (Secretary, the Sierra Club): There was recently a statement made by a scientist that the world is moving toward a higher temperature; the temperature of the world is going up due to the greater use of petroleum fuels and the flowing into the air of CO_2, and part of our economy of the world in keeping the atmosphere in balance is to have more trees that convert the CO_2 back into, I suppose, oxygen and products that we should use. So perhaps we will be working in the right direction.

[The Resolution was adopted as amended without dissent.]

UNIVERSITY COLLEGE AND UNIVERSITY COLLEGE HOSPITAL
MEDICAL SCHOOL, LONDON

The Third
RICKMAN GODLEE LECTURE

THE CALL AND CLAIMS OF NATURAL BEAUTY

DELIVERED BY
PROFESSOR G. M. TREVELYAN, O.M.
IN THE GREAT HALL OF THE COLLEGE

26th OCTOBER, 1931

CHAIRMAN
PROFESSOR EMERITUS SIR THOMAS BARLOW, BT.,
K.C.V.O., F.R.C.P., F.R.S.

On the recto of this leaf is a reproduction to scale of the title page of the pamphlet (32 pages plus cover, 5½ x 8½ inches) from which "The Call and Claims of Natural Beauty" is reprinted. Omitted here is the introduction of Professor Trevelyan by Sir Thomas Barlow, who describes him as a writer of history and biography whose life and service in Italy and the Balkans "have had a great share in strengthening our national sympathy with those nations," and who, moreover, "has presented invaluable tracts of beautiful scenery to be safeguarded in perpetuity for the delight of the English people."

The late Judge Robert W. Sawyer, an honorary life member who was ever helpful to the Sierra Club in its efforts to preserve wilderness, sent this pamphlet to me too soon before his death to have learned of my full appreciation of Professor Trevelyan's lecture (which I am sure Judge Sawyer enjoyed fully) or to see how well it would complement these proceedings.—D.B.

G. M. TREVELYAN

The Call and Claims of Natural Beauty

SIR THOMAS BARLOW, MR. PROVOST, LADY GODLEE, LADIES, AND GENTLEMEN: I had not the pleasure of knowing Sir Rickman Godlee, but I have heard much about him, and I have learnt much in the last few minutes from the very high authority of the Chairman. I have also learnt much from the perusal of his delightful volume entitled *A Village on the Thames**, wherein he studies one after another the antiquities, the natural history and the beauty of the region that he made his home. I have learnt that he was an outstanding example of a type that has always specially attracted me—the specialist who has a wide outlook, broad knowledge and warm enthusiasms outside his own subject as well as in it; and more particularly a man whose mind has been trained in the splendid discipline of a physical science, but whose heart and eyes take also delight in the triumphs of art, the history of man, and the beauties of nature. Such a man is about the best thing that our modern civilisation can produce.

Two things are characteristic of our age and more particularly of our island. The conscious appreciation of natural beauty, and the rapidity with which natural beauty is being destroyed. No doubt it is partly because the destruction is so rapid that the appreciation is so loud. When someone you love is being executed before your eyes, it is natural to cry out.

> Meantime, how much I loved him
> I find out now I've lost him.

The nearer the bone the sweeter the meat.

This passion for natural beauty that consumes so many of us to-day, found recent expression in the most popular of post-war poems, the late poet laureate's *Testament of Beauty*. And in the sphere of practical effort we have National Trusts, Councils for the Preservation of Rural England, Town Plannings and other efforts of Mrs. Partington to sweep back the tide of machine-made ugliness a little while longer—in the desperate hope that the tide will some day turn, or consent at least to be channelled into limited streams and lakes, leaving to posterity some islands of the blest. Whether all this feeling and effort is to prove vain or not wholly vain, whether it be a rearguard action or a march to some modified victory, in any case many of us feel we must fight it to the end because of the faith and fire within us.

It is quite possible that our ancestors were as fond of natural beauty as we are, but they talked less often and less elaborately about it. Self-consciousness, the examination and proclamation of personal feelings is a modern characteristic, in this as in other matters. Moreover, in our time, most people live buried deep in ugly towns, removed from every natural sight and sound save a strip of sky far overhead and the swish of rain on dirty streets. It is only on high days and holidays that we go out into the country, and therefore we more consciously relish

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* *A Village on the Thames, Whitchurch Yesterday and To-day*. George Allen & Unwin. 7s. 6d.

Our holiday of delight
In the beams of the God of the Muse.

Even Milton, the cockney, had that experience in a modified form:

As one who long in populous city pent,
Where houses thick and sewers annoy the air,
Forth issuing on a summer's morn to breathe
Among the pleasant villages and farms
Adjoined, from each thing met conceives delight,
The smell of grain, or tedded grass, or kine—

And if it was so with Milton, it is very much more so with us, for we are now nine-tenths of us cockneys—city-dwellers—and in *such* cities, compared to which old London, for all its annoying sewers, was a paradise of beauty.

Our ancestors, most of whom lived all the year round in unadulterated rural surroundings, took less conscious note of natural beauty, because it was the common air they breathed, the element in which they lived and moved. It pervaded and formed their minds and personalities. The Cavaliers drew their charm from the fields and the Roundheads their strength from the earth. Cavalier and Roundhead are alike a vanished race, for they are not to be bred under the influences of modern city life, machinery and the cheap press of today. So too it was the influence of the fields and woods of Elizabethan England that fostered the thousand-and-one lyric poets and musicians, those

Bards who died content on pleasant sward,
Leaving great verse unto a little clan.

—the high-hearted company of English minstrels of that day, of whom Shakespeare was but the finest flower. Such poetry was as characteristic an expression of that country life, and its influences, as problem and detective novels are of the mechanical life of to-day. If we cannot save something at least of England's rural beauty, I do not believe there is any future for English poetry, or for the types of thought, feeling and aspiration to which poetry is akin.

The Elizabethan song-men had no doubt a certain consciousness of their own delight in natural beauty—

By shallow rivers to whose falls
Melodious birds sing Madrigals.

They too could notice the sun

Gilding pale streams with heavenly alchemy.

But theirs was a simpler, more childlike delight in the obvious that was always around them. The modern attitude to natural beauty, more philosophic and more conscious, began, in this country at least, with Wordsworth, who gave it not only its first but its finest expression. That is why he still appeals to so many of us to-day.

Going back to Chaucer's time we find the same influence of natural beauty as in the age of Shakespeare. I will give two examples from that period; the first shall represent the conscious delight in natural beauty, simple and unphilosophical indeed, but awake and intense. It comes from that beautiful poem *The Cuckoo and the Nightingale* which Wordsworth admired and modernised so successfully. But I quote the original version:

There sate I down among the fairé flours
And saw the birds trip out of hir bours,
There as they rested hem all the night
They were so joyful of the dayés light
They began of May for to done honours.

They could that service all by rote,
There was many a lovely note,
Some song loud, as they had plained,
And some in other manner voice yfained,
And some all out with the full throte.

And the river that I sate upon
It made such a noise as it ron,
Accordaunt with the birdes armony,
Me thought it was the best melody
That might ben yheard of any mon.

I think the last Rickman Godlee lecturer, Lord Grey of Fallodon, would agree with that old English poet that the sound of birds singing by falling water was

the best melody
That might ben yheard of any mon.

And now, from Chaucer himself, I will take a few lines to illustrate the unconscious effect of the all-pervading atmosphere of natural beauty, of natural sights and sounds, on the thought and language of the men of that age and country. Chaucer is describing a beautiful and sprightly young woman, and he does so in four metaphors—one taken from the minted gold, the other three from familiar, vulgar rural sights and sounds and smells.

Ful brighter was the shining of hire hewe
Than in the Tower the noble iforged newe.
But of her song it was as loud and yerne (brisk)
As any swalow sitting on a berne (barn).

Thereto she could skip and make a game
As any kid or calf following his dame.
Hire mouth was sweet as bracket or the meth (honeyed ale or mead)
Or hord of apples laid in hay or heth.

How simple, strong yet exquisite it is—a lost strength and simplicity, because the influences of daily life that made it are lost, or at least far less prevalent and overmastered by others more mechanical and ugly.

We, I fear, can never again expect to live under the continual and ubiquitous influence of natural and lovely sights and sounds. Through the conquests of science over nature, the human race has assigned to itself another destiny. Our present lot has its compensating advantages on the material side and in some respects on the intellectual side also. Doubtless the city life of to-day can in many respects be preferred to the rustic seclusion of old. I am not debating the general question of relative loss and gain, or trying to strike a balance. But to many of us city life can only be rendered tolerable on the condition of frequent holidays in the real country, and for that reason, if for no other, the real country must be preserved in sufficient quantity to satisfy the soul thirst of the town dweller. That the unspoilt countryside is worth something also to its regular inhabitants, the downtrodden race of English agriculturalists, is another fact, too frequently ignored.

The appeal of natural beauty is not a single, simple thing. The aspect of nature varies from place to place and day to day; and its appeal is made to the highly composite mind of modern man, which contains an infinity of aptitudes, tastes, desires, traditions, mysticisms, primeval inheritances and physical and physiological urgings, to all of which natural beauty makes, in a variety of ways, its strange and haunting appeal. To analyse that appeal is, therefore, not easy. Indeed, how can we analyse it at all without doing wrong to its delicate and fugitive spirit. "We murder to dissect." Yet, without pretending to make either a philosophical or a scientific analysis, I should like to pass a few remarks about the call of natural beauty, as I hear it.

It is clear, as I have said, that its appeal is made up of several, perhaps of many, different elements, so inextricably blended in their action upon us that we can with difficulty distinguish them apart.

Obviously one appeal is the æsthetic, the mere beauty of form and colour apart from all association. Few would deny that general statement. Yet even here we are in the region of disputes, for on æsthetics there are many different views held in different times and places. A highly cultivated clergyman of the mid-eighteenth century, banished to the remote Rectory of Elsdon in Northumberland, wrote to his friends in the South that in the summer the moors around him were covered by the purple flower of a plant called ling, which made the landscape "indescribably hideous." Yet some of us like heather for its colour, as well as for its smell, and I should add for its "feel"—or, in æsthetic parlance, its "tactile value."

Again, a living artist of high name and accomplishment, once told a friend of mine, then his pupil at the Slade, that he should not paint bluebells in grass, because green and blue made a cacophony of colour. That may be true of those colours in a room—I am no judge—yet in early summer woods the combination of green and blue, even in its æsthetic aspect, seems to have charms for the human race. And the varieties of green in the early English summer makes our island, whenever the sun shines on it, at moments the loveliest spot on earth.

But the æsthetic appeal does not by any means make up the whole appeal of natural beauty, though it enters into and enhances all the other subtle and strange emotions that mankind feels in the presence of nature. One of these calls of nature is the sense of life and youth ever renewed, the eternal recurrence of spring—at once allegory and reality, the mighty mother for ever and for ever reborn. What joy when after a long winter one looks out into the garden and sees by some little sign that incorrigible old Mother Earth is "at it again." The crocus, pushing up its golden finger through the still half-frozen sod, aspiring out of darkness to light and life and warmth, fills us with a sense of joy, more primeval and powerful than the mere delight in its yellow colour. The thrush or blackbird's "mellow fluting note,"

> Sings us out of winter's throat
> The young time with the life ahead.

These instances you may call religious or what you will; but they are older than any formal religion, older than *homo sapiens* himself. This joy in spring and early summer inspired prehistoric man to make those strange old rites and legends which Sir James Frazer has collected in the Golden Bough. Chaucer is full of it, from the first line of the Canterbury Tales onwards. Such joy in the reviving year is natural to all the animals, to all the children of the Great Mother, to all the inhabitants of earth of whom man is one—save only in so far as he shuts himself up in cities and ceases to be a part of free, visible nature. And then, being cut off from these yearly sights and sounds that are natural to him by an infinitely long inheritance, he broods, pines, is miserable, mutinous, wants very often he knows not what, and goes off into follies, madnesses and meannesses innumerable.

But it is not only in the spring that we feel the love of growing things. It is a natural, brotherly love that we feel for trees, flowers, even for grass, nay even for rocks and water. We and they are all, literally, children of earth, for we have been evolved as science teaches us, out of earth by infinite generations. We are, literally as well as allegorically, brothers and sisters of a family, and when a beautiful æsthetic form has been given to our brother the tree, or our sister the water leaping over our brother the rock, we feel our kinship and delight in them and in their pulsing life, with a feeling of attachment stronger than the mere æsthetic pleasure, although that is certainly a great part of the sentiment. I do not mean that this family feeling of kinship with nature is often a conscious thought, but it is, I believe, at the back of our impulse towards nature, and there are moments when I for one am strongly conscious of it. George Meredith's poetry gave the most definite expression to this idea of our family relationship to earth and nature, an expression sometimes too philosophical for the purposes of poetry, but when it was purely poetic as in *Love in a Valley* and the *Day of the Daughter of Hades,* most powerful in its charm.

Man, as far back as we have evidence about his feelings, has always rejoiced in nature. But not all of mankind has rejoiced in the whole of nature. There has always been picking and choosing. The Arab has seen God in his deserts, where more casual visitors have only seen the Devil. The wild Highlanders have loved their rugged mountains from before the days of Ossian. But those mountains were, until recently, a horror to the lowlander and above all to the Englishman, though the Englishman rejoiced in his own green and ordered landscape of field, hedgerow and coppice. I should like, with your permission, to examine a little this change of our attitude with regard to mountain scenery; the change is almost identical in time and progress with the march of the industrial revolution, and has, I think a certain causal connection with it.

Let us first state the case for the old horror of mountains felt by civilised man until the latter part of the eighteenth century. I quote the *locus classicus,* Mr. Burt's letters, written to a friend, about 1725–7, from the Highlands of Scotland. This observant and highly intelligent gentleman was not a mere casual visitor to the Highlands; he lived among those wild hills for some years, as civil adviser of General Wade in the construction of his famous roads, the first thrust of civilisation into that heart of old darkness. But Burt had not been born and bred among the mountains, and he had never met a civilised man who pretended to admire them. He had therefore no idea that admiration was their due. Here is what he wrote in his simplicity, very interesting to us to-day:

> The summits of the highest (mountains) are mostly destitute of earth; and the huge naked rocks, being just above the heath, produce the disagreeable appearance of a scabbed head. Those ridges of the mountains that appear next to the ether, by their rugged irregular lines, the heath and black rocks, are rendered extremely harsh to the eye. But of all views, I think the most horrid, to look at the hills from east to west, or *vice versa;* for then the eye penetrates far among them, and sees more particularly their stupendous bulk, frightful irregularity, and horrid gloom, made yet more sombrous, by the shades and faint reflections they communicate one to another.

Observe that it was not from want of carefully observing the form and chiaroscuro of mountains that Burt failed to appreciate them. In the next passage that I shall quote, Burt indicates one of the causes of the dislike felt by civilised man for mountains in those days, his lively fear of the fate that was apt to befall him amid their recesses. As Macaulay pointed out, the fear of having one's throat cut at the next turn of the track, was not conducive to picturesque raptures amid Highland scenery. The ruggedness of the mountains was associated in the mind of the lowland visitor with the lawless character of the inhabitants, the hard quality of board and lodging, the unbridged torrents and paths winding perilously among precipices. In this connection Burt writes:

> In passing to the heart of the Highlands we proceed from bad to worse, which makes the

> ***worst of all*** the less surprising. But I often heard it said by my countrymen, that they verily believed, if an inhabitant of the South of England were to be brought blindfold into some narrow rocky hollow, inclosed with these horrid prospects, and there to have his bandage taken off, he would be ready to die with fear, as thinking it impossible he should ever get out to return to his native country.

Burt was by no means insensible to natural beauty. But his idea of a "poetical mountain" was Richmond Hill, rising amid the green, luxuriant landscape of South England. That was the hill, the hill for him:

> Now what do you think [he continues] of a poetical mountain, smooth and easy of ascent, clothed with a verdant, flowery turf, where shepherds tend their flocks, sitting under the shade of tall poplars, etc? In short what do you think of Richmond Hill, where we have passed so many hours together delighted with the beautiful prospect? But after this description of these [Scottish] mountains, it is not unlikely you may ask, of what use can be such monstrous excrescencies?

But in the next paragraph the purposes of the Creator are explained, on the ground that the Highland mountains contain minerals, break the clouds, replenish the rivers, and serve for the breeding of cattle.

This passage, comparing Richmond Hill so favourably with the Highlands, is much the same as the sentiment of that old ballad writer of the Lady and her Demon Lover.

> 'O what are those hills; those pleasant hills
> That the sun shines sweetly on?'
> 'O those are the hills of heaven,' he said,
> 'Where you will never win.'
>
> 'And what is that mountain there,' she said,
> 'So dreary with frost and snow?'
> 'O that is the mountain of hell,' he said,
> 'Where you and I must go.'

How very different are our feelings to-day. It is not that we love Richmond Hill less (except in so far as we have spoilt it by urbanisation)—but that we have learnt to love the Highlands and the snowy Alps also. There are, I think, more reasons than one for this change. In the first place there has been a change in æsthetic appreciation—our tastes are wider, we still love the woodland hedgerow, but we love the black rugged line of rocks on the skyline, in spite of, or on account of, its irregularity and darkness The chiaroscuro of light and shade in a highland strath pleases instead of repelling our taste. This is, in part, a matter of growth or fashion in æsthetics; I state the fact, but I do not attempt to analyse it in so far as it is purely æsthetic.

But as regards associated ideas that have greatly contributed to this change of taste, I have something to say. No doubt Macaulay was right in attributing the dislike felt by our ancestors for mountain scenery in part to the danger, hardship and discomfort that then attended a tour in the Highlands. Yet that does not cover all the ground. Between 1915 and 1918 I knew a great many people whose daily occupation it was to be in danger of being shot among the Alps, yet who did not for that reason fail to appreciate their beauty. And the modern mountaineer, though he likes his hardships moderated, deliberately seeks danger as an element in his relation to the mountains. The climber does his best not to be killed, but the danger such as it is is his own choice and creation.

The Spartan psychology of the modern mountaineer has been stated by Meredith in the 53rd chapter of *Harry Richmond.*

> Carry your fever to the Alps, you of minds diseased: not to sit down in sight of them ruminating, for bodily ease and comfort will trick the soul, and set you measuring our lean humanity against yonder sublime and infinite; but mount, rack the limbs, wrestle it out among the peaks; taste danger, sweat, earn rest: learn to discover ungrudgingly that haggard fatigue is the fair vision you have run to earth, and that rest is your uttermost reward. Would you know what it is to hope again and have all your hopes in hand?—hang upon the crags at a gradient that makes your next step a debate between the thing you are and the thing you may become. There the merry little hopes grow for the climber like flowers and food, immediate, prompt to prove their uses, sufficient if just within the grasp, as mortal hopes should be. How the old lax life closes in about you there! You are the man of your faculties nothing more. Why should a man pretend to be more? We ask it wonderingly when we are healthy. Poetic rhapsodists in the vales below may tell you of the joy and grandeur of the upper regions, they cannot pluck you the medical herb. He gets that for himself who wanders the marshy ledge at nightfall to behold the distant Sennhüttchen twinkle, who leaps the green-eyed crevasses, and in the solitude of an emerald alp stretches a salt hand to the mountain kine.

We must, therefore, I think, say that although the march of civilisation, security and comfort into the Alps and Scottish Highlands has been a necessary condition of their wide popularity, it is not in itself an explanation of the modern love of mountains. That we must seek elsewhere.

I believe that the modern æsthetic taste for mountain form, is connected with a moral and intellectual change, that differentiates modern civilised man from civilised man in all previous ages. I think that he now feels the desire and need for the wildness and greatness of untamed, aboriginal nature, which his predecessors did not feel. One cause of this change is I think the victory that civilised man has now attained over nature through science, machinery and organisation, a victory so complete that he is denaturalising the lowland landscape. He is therefore constrained to seek nature in her still unconquered citadels, the mountains. Even that citadel he will soon conquer and desecrate unless he takes thought: are we not even now struggling against Sty Head and Wrynose Roads and the prospect of hotels on our mountain tops?

A new form of human desire has, under these conditions, arisen to get away from the vulgarity of man's triumph over nature, back to the old beginnings, to nature as God made her, as first she rose from the deep of time. Another use has been found for Mr. Burt's horrid mountains, in a way that he did not foresee; the providence and foresight of the Creator has been further justified.

This taste for mountain scenery, this love of nature in its most natural and unadulterated form, has grown *pari passu* with the Industrial Revolution. Watts and Stevenson were contemporaries of Rousseau and Wordsworth, and the two movements have gone on side by side ever since, each progressing with equal rapidity.

The first sign of the change in taste was the movement for landscape gardening. In the later eighteenth century, Capability Brown persuaded the noblemen and gentlemen of England to apply the hand of taste to their estates, and to bring the grass and trees of their parks up to the walls of their country seats, abolishing the formal Dutch and Versailles gardens in which their grandfathers had rejoiced. He was appealing to a new-born desire for wildness. That desire to go back from the artificial to the natural in landscape gardening, resulted from the fact that nature had been by that time sufficiently tamed in England and was even getting a little too tame. The enclosures of the eighteenth century were turning south England into a chess-board—a very pretty green chess-board certainly, but less irregular and less accidental than the heaths, forests, commons and irregularly shaped fields that were vanishing before the march of progress. In ancient and mediaeval times, when man was still battling with forest, fen and heath, the lords of creation desired to retire occasionally from the wild aspect which was then nature's normal appearance, and take refuge in formal gardens made for their delight. The grandees of the Roman Empire had loved their gardens, deep with ordered shade and shine. So too the Mediaeval pleasaunce had been trim and rectangular, as you can see in MSS. illuminations, a plot of order in the surrounding wild. And such was the ideal of a garden and pleasaunce until in the middle of the eighteenth century the ordinary landscape had become so tame that men began to desire a little more wildness, such wildness at least as an English parkland affords.

We, in our turn, have to complain of worse outrages on nature than the enclosure of square fields in lovely hedgerows. And the parklands, attacked as public nuisances by the wisdom of our statesmen and financiers, are as rapidly as possible to be turned into building estates. So it's awa to the hielands, Lizzy Lindsay—there is no other refuge. Or to the Alps themselves, where we address nature in Matthew Arnold's words:

To thee only God granted
  A heart ever new—
To all always open,
  To all always true.

Ah! calm me, restore me;
  And dry up my tears
On thy high mountain-platforms
  Where morn first appears;

Where the white mists, for ever,
  Are spread and unfurl'd,—
In the stir of the forces
  Whence issued the world.

You will note in those lines of Matthew Arnold a personifying of nature in the Alps, as a friend and comforter to the individual man.

To thee only God granted
  A heart ever new—
To all always open,
  To all always true.

Nature, no doubt, acts as a comforter and giver of strength even in southern woodlands and on smooth hillsides. But to many of us the moorland and the mountain seem to have more rugged strength and faithfulness with which in solitude we can converse and draw thence strength and comfort. And the mountain above all seems to have personality which says to us as we gaze on it at evening from the valley-head below—"I know, I understand. Such is the lot of man. I have watched him through the ages. But there is a secret behind. It will always be a secret." That at least is what the mountains say to me when they talk. To others they may say something different. But to many they have something important to say, whatever it may be. If this personality of mountains is a fallacy, it is none the less a potent and beneficent emotion. It is one of the ways by which men see God. It is one of the sacraments prepared for man, or discovered by man.

This sense of personality in the mountain has been nobly rendered by Browning in his *Saul*:

Have ye seen when Spring's arrowing summons goes right to the aim,
And some mountain, the last to withstand her, that held (he alone,
While the vale laughed in freedom and flowers) on a broad bust of stone
A year's snow bound about for a breastplate—leaves grasp of the sheet?
Fold on fold all at once it crowds thunderously down to his feet,
And there fronts you, stark, black, but alive yet, your mountain of old,
With his rents, the successive bequeathings of ages untold—
Yes, each harm got in fighting your battles, each furrow and scar
Of his head thrust 'twixt you and the tempest—all hail, there they are!
—Now again to be softened with verdure, again hold the nest
Of the dove, tempt the goat and its young to the green on his crest
For their food in the ardours of summer.

And in our own day Miss Margaret Cropper, in her poem *The Broken Hearthstone* has expressed the same idea of the personality of a mountain in a different but no less marvellous manner.

But while we may note, account for and approve this recent tendency of super-civilised man to seek for nature in her most natural and uncompromising forms, we do not any the less love the ordered lowland landscape of hedgerow and covert, meadow and cornland, with farm and village nestling into the scene as an essential part of its purely æsthetic beauty, and of its association and intimate appeal. Here, in the South-English landscape, wherever it has not yet been spoiled, we have what we may call the marriage of man's work and nature's in perfect harmony. It reached its culminating point of perfection in the reign of George III, with the last enclosures, the great plantations of woodland estates and parks round the country seats, and the building in great profusion of substantial but beautiful farms, farmbuildings and cottages harmonious with the landscape. I think the island as Wordsworth and Keats knew it must have been even more beautiful than in its wilder state in olden times. But after that, with extraordinary rapidity, a change came over the spirit of the scene. In the nineteenth century the machine age, commonly called the Industrial Revolution, destroyed our native school of architecture, debauched the taste for awhile even of the most cultivated persons, and substituted for the beautiful materials of which old buildings and fences were constructed, materials which were ugly in proportion as they were cheap, in proportion therefore as they were imposed by economic necessity on the improver. By the end of the nineteenth century it was already true that almost all that was old was beautiful, almost all that was new was either ugly in itself, or in shrieking disharmony with the natural beauty amid which it was set.

In the twentieth century, so far as it has yet gone, two things have happened. The taste of the cultivated classes and of a very large proportion of all classes has greatly improved in architecture, and the desire to preserve natural beauty has become widely spread. But this change has not yet had more than a very slight influence on the action of the State, which continues to be increasingly inimical to natural beauty by its activities, particularly in taxation. And, moreover, the advent of the motor car, though it enables the dweller in our unhappy cities to enjoy relief in the country more easily, is plastering the countryside with horrors of bungalows, advertisements and ugly houses in the wrong places at a pace of which the Victorians might perhaps have been proud, but which they were fortunately unable to rival for lack of the internal combustion engine. The Victorians at least acted up to their own ideals like the moral, serious folk they were. They did the best they knew, even though in our eyes much of that best was bad. But we sin against our own light. We know that we are disfiguring England and murdering beauty, yet we continue to do so.

> Video meliora proboque,
> Deteriora sequor.

Or, to speak more precisely, those of us who care for preservation of natural beauty are still outnumbered and overborne by those who, though not all of them wholly indifferent to our cause, place other considerations whether of business or of politics in a higher place than any such considerations.

As the centuries pass the mystery of the Universe deepens. The thoughts of civilised man accumulate like snowflakes on the summit of Everest, or the leaves of many years in winter woods, burying one past system after another, one fashion after another in religion, science, poetry and art. Knowing that so much lies buried beneath, which but now was so hot and certain, it becomes ever more difficult to trust so implicity as of old whatever still for the moment lies on the surface of human thought, the still surviving dogma, or the latest fashion in opinion. At least it becomes difficult to trust either to dogma or to thought alone. Man looks round for some other encouragement, some other source of spiritual emotion that will not be either a dogma or a fashion, something

> That will be for ever,
> That was from of old.

And then he sees the sunset, or the mountains, the flowing river, the grass and trees and birds on its banks. In the reality of these he cannot fail to believe, and in these he finds, at moments, the comfort that his heart seeks. It still is so with us, as it was with that old contemporary of Chaucer who wrote *The Cuckoo and the Nightingale* and gave this advice to an unfortunate lover:

> 'Yay, use,' quoth she, 'this mediceine,
> Every day this May ere thou dine
> Go look upon the fresh daisy,
> And though thou be for woe in point to die
> That shall full greatly lessen thee of thy pine.'

By the side of religion, by the side of science, by the side of poetry and art, stands Natural Beauty, not as a rival to these, but as the common inspirer and nourisher of them all, and with a secret of her own beside.

The appeal of natural beauty is more commonly or at least more consciously felt to-day than ever before, just because it is no new argument, no new dogma, no doctrine, no change of fashion, but something far older yet far more fresh, fresh as when the shepherd on the plains of Shinar first noted the stern beauty of the patient stars. Through the loveliness of nature, through the touch of sun or rain, or the sight of the shining restlessness of the sea, we feel

> Unworded things and old to our pained heart appeal.

And to the young who have no pain, who have not yet kept watch on man's mortality, nature is a joy responding to their own, haunting them like a passion.

This flag of beauty, hung out by the mysterious Universe, to claim the worship of the heart of man, what is it, and what does its signal mean to us? There is no clear interpretation. But that does not lessen its value. Like the Universe, like life, natural beauty also is a mystery. But whatever it may be, whether casual in its origin as some hold who love it well, or whether as others hold such splendour can be nothing less than the purposeful message of God—whatever its interpretation may be, natural beauty is the ultimate spiritual appeal of the Universe, of nature, or of the God of nature, to their nursling man. It and it alone makes a common appeal to the sectaries of all our religious and scientific creeds, to the lovers of all our different schools of poetry and art, ancient and modern, and to many more beside these. It is the highest common denominator in the spiritual life of to-day.

Yet now that it is most consciously valued, it is being most rapidly destroyed upon this planet, and above all in this island. In old days it needed no conservation. Man was camped in the midst of it and could not get outside it, still less destroy it. Indeed, until the end of the eighteenth century the works of man only added to the beauty of nature. But science and machinery have now armed him with weapons that will be his own making or undoing as he chooses to use them; at present he is destroying natural beauty apace in the ordinary course of business and economy. Therefore, unless he now will be at pains to make rules for the preservation of natural beauty, unless he consciously protects it at the partial expense of some of his other greedy activities, he will cut off his own spiritual supplies, and leave his descendants a helpless prey forever to the base materialism of mean and vulgar sights.

This matter has become a public question of the first magnitude. The value of natural beauty is admitted in words by our public men, but when it comes to deeds the doctrine is too new to bear much fruit. It has for centuries been held sacrilege to destroy a church, so churches are guarded from destruction and even exempted from taxation. But a place of natural beauty may be destroyed, and is now actually to be taxed by the State in order that it may the sooner be sold to the jerry-builder. Meanwhile, the State itself pours forth the money of ratepayer and tax-payer for the perpetration all over the island of outrages on the beauty of the country. Those who mourn over the destruction of abbeys long ago, should look also at the beam in our own eye, and hasten to save from destruction or disfigurement parks, woodlands and valley heads.

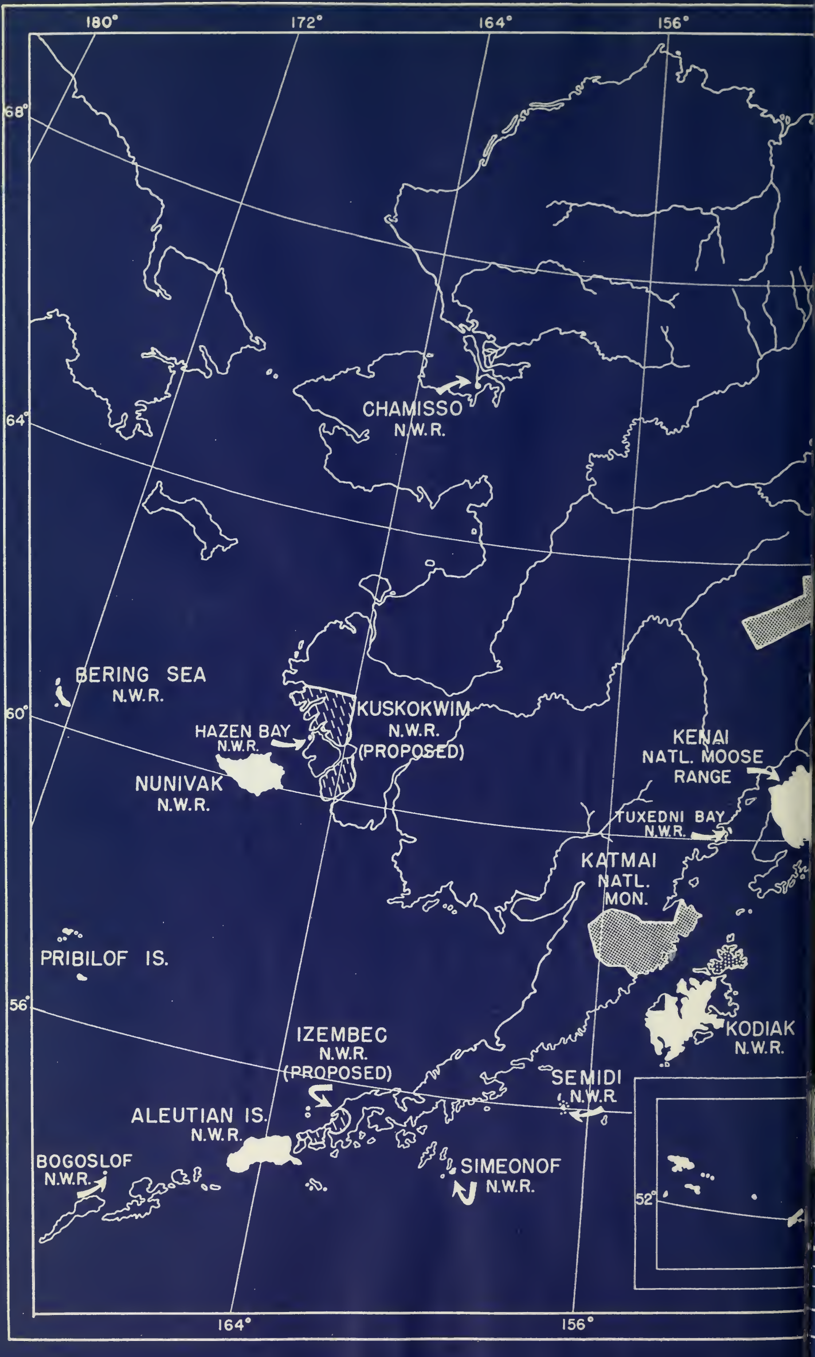
This is a civic duty that cannot any longer be neglected without dire consequences. Destruction walks by noonday. Unless the State reverses the engines and instead of speeding up destruction, plans the development of the country so that the minimum of harm can be done to beauty, the future of our race, whatever its social, economic and political structure may be, will be brutish and shorn of spiritual value.

Conservation—and Tinkering

CONSERVATION is a state of harmony between men and land. By land is meant all of the things on, over, or in the earth. Harmony with land is like harmony with a friend; you cannot cherish his right hand and chop off his left. . . .

The outstanding scientific discovery of the twentieth century is not television, or radio, but rather the complexity of the land organism. Only those who know the most about it can appreciate how little we know about it. The last word in ignorance is the man who says of an animal or plant: 'What good is it?' If the land mechanism as a whole is good, then every part is good, whether we understand it or not. If the biota, in the course of aeons, has built something we like but do not understand, then who but a fool would discard seemingly useless parts? To keep every cog and wheel is the first precaution of intelligent tinkering.

—ALDO LEOPOLD, in *Round River* (Oxford, 1953)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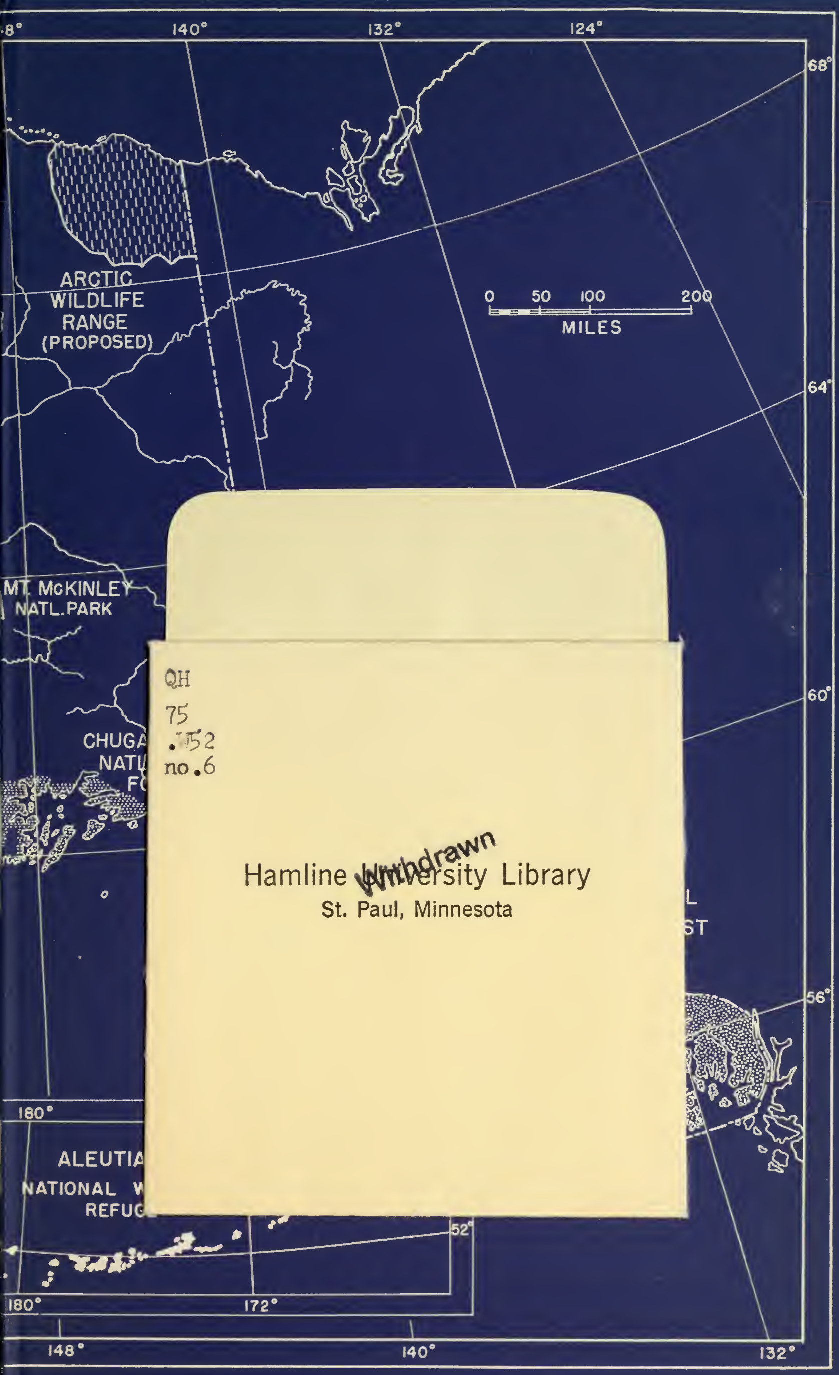

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